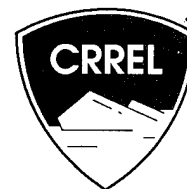


SPECIAL REPORT 95-17

SPECIAL REPORT

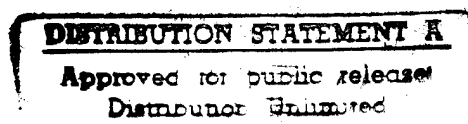
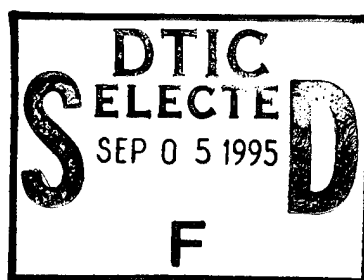


Northern Sea Route Reconnaissance Study

A Summary of Icebreaking Technology

Devinder S. Sodhi

June 1995

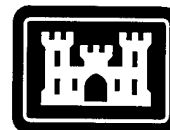


Abstract

Since the advent of steam power, icebreakers have been built to navigate in ice-covered waters. The hull forms of early icebreakers were merely an adaptation of open water hull shapes, by sloping bow angles more to create vertical forces for breaking ice in bending. However, these bow forms were found to be unsuitable for sea-going vessels because they push broken ice ahead of them. This experience led to construction of all sea-going vessels with wedge-shaped bows from 1901 to 1979. With the introduction of low-friction coatings and the water-deluge system, it is now possible to operate ships with blunt bows efficiently in broken ice. New developments in marine propulsion technology have also been incorporated to obtain better icebreaking efficiency and performance. Both fixed-pitch and controllable-pitch propellers are in use. Nozzles surrounding the propellers are also used to increase the thrust and to reduce ice-propeller interaction. Electrical and mechanical transmission systems have been used in icebreakers to improve the characteristics of the propulsion system. Though many types of prime movers are used in icebreakers, medium-speed diesel engines are the most popular because of their overall economy and reliability. Appendix A is a description of the Russian icebreaker Yamal, which is one of the largest and most powerful icebreakers of the world today. Appendix B contains an inventory of existing ships that are capable of navigating in at least 0.3-m-thick ice. Some of the present icebreakers are capable of navigating almost anywhere in the ice-covered waters of the Arctic and the Antarctic, and multi-purpose icebreakers have been built to operate not only in ice during the winter but also in open water doing other tasks during the summer. With sufficient displacement, power, navigation equipment, and auxiliary systems, future icebreakers that can operate independently year-round in the Arctic and the Antarctic are well within the known technology and operational experience.

For conversion of SI units to non-SI units of measurement consult ASTM Standard E380-93, *Standard Practice for Use of the International System of Units*, published by the American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

This report is printed on paper that contains a minimum of 50% recycled material.



**US Army Corps
of Engineers**

Cold Regions Research &
Engineering Laboratory

Northern Sea Route Reconnaissance Study

A Summary of Icebreaking Technology

Devinder S. Sodhi

June 1995

Accession For	
NTIS	CRA&I <input checked="" type="checkbox"/>
DTIC	TAB <input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	

19950901 062

Prepared for
U.S. ARMY ENGINEER DISTRICT, ALASKA

DTIC QUALITY INSPECTED 5

Approved for public release; distribution is unlimited.

PREFACE

This report was written by Dr. Devinder S. Sodhi, Research Engineer, Ice Engineering Research Division, Research and Engineering Directorate, U.S. Army Cold Regions Research and Engineering Laboratory. It represents a part of the investigations supporting a Reconnaissance Study of the Northern Sea Route. The project was funded by the U.S. Army Engineer District, Alaska. Dr. Orson Smith was the Project Manager.

The author is indebted to Leonid Tunik and Alfred Tunik for compiling the information on icebreakers (presented in Appendix B); Captain Lawson Brigham, Commanding Officer of the USCG *Polar Sea*, for providing information, photographs, suggestions, and valuable background material; Dr. Jean-Claude Tatinclaux, Chief, Ice Engineering Research Division, for providing many references and for reviewing this report; Kevin Carey, Research Hydraulic Engineer, Ice Engineering Research Division, for technically reviewing the manuscript; and Walter B. Tucker, III, Chief of the Snow and Ice Division, for providing information on, and photographs of, the icebreakers at the North Pole. The author thanks the members of the Reconnaissance Study team for their guidance and suggestions.

The author also gratefully acknowledges the dedicated work of the following CRREL personnel in the preparation of this report: Nancy Liston and Elizabeth Smallidge for procurement of publications and reports, Matthew Pacillo and Edward Perkins for preparation of the figures, and Lourie Herrin for typing assistance.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.

CONTENTS

	Page
Preface	ii
Introduction	1
Early history	1
Recent history	5
Inventory of icebreaking ships	6
Sizes and dimensions	7
Beam	7
Depth	7
Draft	7
Maximum deadweight	7
Hull forms	8
Bow shape	8
Midbody shape	10
Stern shape	10
Icebreaker performance with different hull forms	11
Structural design of polar ships	12
Classification of polar ships	12
Ice loads and pressures	12
Materials	13
Welding	14
Plating	14
Framing	14
Propulsion system	15
Propellers	16
Shafting	17
Mechanical transmission components	17
Electrical transmission systems	17
Azimuth propulsion drive	18
Prime movers	19
Auxiliary systems	21
Low-friction hull coating	21
Heeling system	22
Air-bubbler system	22
Air-bubbler-water injection system	23
Water-deluge system	23
Power and performance	23
Fuel consumption rates	23
Performance prediction	24
Future icebreakers	28
Summary	30
Literature cited	30
Appendix A: Information about the nuclear icebreaker <i>Yamal</i>	33
Appendix B: An inventory of existing ships that are capable of navigating in at least 0.3-m-thick ice cover	35

ILLUSTRATIONS

Figure	Page
1. The Russian icebreaker <i>Yamal</i> , the Canadian icebreaker <i>Louis S. St. Laurent</i> , and the U.S. icebreaker <i>Polar Sea</i> during the expedition to the North Pole in August of 1994	3
2. Significant events in the development of polar ship technology since 1955	4
3. Design evolution of Russian polar icebreakers	5
4. <i>Taymyr</i> -class shallow-draft nuclear icebreaker	6
5. Dimensions of vessels	7
6. Maximum deadweight vs. overall length of all vessels listed in Appendix B	8
7. Main features of bow forms	9
8. Different shapes of icebreaking bows	9
9. Hull form of the Finnish multipurpose icebreakers <i>Finnica</i> and <i>Nordica</i>	10
10. Icebreaking capabilities of three sister ships with different bow shapes in terms of speeds in level ice of different thicknesses at a power level of 16.2 MW	11
11. Ship speed vs. equivalent ice thickness during tests in broken ice with three sister ships having different bow shapes	11
12. Measured effective pressure vs. contact area	13
13. Plane strain fracture toughness vs. temperature for two grades of steel	13
14. Pressure vs. deflection, showing domains of different behaviors from small to large deflection	14
15. Shaft power vs. year of construction for icebreaking ships	15
16. Shaft power vs. propeller diameter for icebreaking ships	16
17. Differences between diesel-mechanical and azimuth installations	19
18. Prime movers installed on icebreaking ships	19
19. Outboard profile and topside deck plan of the Swedish icebreaker <i>Oden</i>	22
20. Power vs. beam for icebreakers	23
21. Icebreaking performance: bollard pull/beam vs. ice thickness	23
22. Speeds and power levels of U.S. icebreaker <i>Polar Sea</i> during her transit from 23 March to 4 April 1983	25
23. Number of ramming operations during the transit of U.S. icebreaker <i>Polar Sea</i> from 23 March to 4 April 1983	26
24. Specific net thrust vs. speed at maximum shaft power, indicating propulsive performance	27
25. New "iceraking" concept, as proposed by Johansson et al.	29

TABLES

Table	
1. Selected important icebreaking voyages in recent years	2
2. Estimates of daily fuel consumption for a <i>Polar</i> -class icebreaker	24
3. Fuel consumption rates of a few Russian ships according to the information given in the brochures of the Murmansk Shipping Company	24
4. Performance criteria for a Northwest Passage icebreaker	28
5. Comparison of design parameters of proposed Northwest Passage icebreaker with those of the <i>Yamal</i>	28

Northern Sea Route Reconnaissance Study

A Summary of Icebreaking Technology

DEVINDER S. SODHI

INTRODUCTION

In the last four to five decades, many developments in icebreaking technology have taken place through the application of modern marine technology to the design and the operation of polar ships. Innovative ideas have been implemented to improve the propulsion systems and to reduce the resistance encountered during icebreaking. Present navigation and information systems (e.g., ice maps, satellite images, etc.) aboard polar ships enable navigators to identify ice features along the transit route in near real time and to chart a tactical course. As a result of this, it is possible to travel by ships to remote polar regions that were thought to be unreachable only a few years ago. Many nations have contributed to this development by designing and building polar ships and by launching voyages to various regions of the Arctic and the Antarctic. Some of the landmark voyages during the last four decades are listed in Table 1 (Brigham 1992). Recently, Russian nuclear-powered icebreakers have regularly traveled to the North Pole. In August of 1994, the U.S. icebreaker *Polar Sea*, the Canadian icebreaker *Louis S. St. Laurent* and the Russian nuclear icebreaker *Yamal* (App. A) met at the North Pole (Fig. 1).

The impetus behind these technological advances has come from:

1. The exploration for natural resources around the Arctic Basin.
2. The development of the Northern Sea Route by the former Soviet Union, as an integral part of development of the entire Russian Arctic.
3. The need for multi-mission ships for the transportation of personnel, logistics and marine research in the Antarctic.

Although exploration for hydrocarbon resources in the southern Beaufort Sea has almost

stopped, plans are being discussed for developments in the offshore areas of the Russian Arctic to produce hydrocarbon resources and to transport them to world markets. Future shipments of these resources will have significant effects on the development of the Northern Sea Route.

From the perspectives of a master mariner, the performance of icebreakers depends on the construction limitations of the vessels and the skills in ice navigation of their captains (Toomey 1994). Although the technological improvements incorporated in the design and construction of an icebreaker help to increase its performance in ice, it is essential to have a skilled captain and crew operating the ship to exploit these advantages to the maximum extent. Therefore, the training and the experience of the crew operating an icebreaker are important elements in its performance. A knowledgeable, skilled captain, supported by extensive information, can prevent or quickly overcome many difficulties along a route.

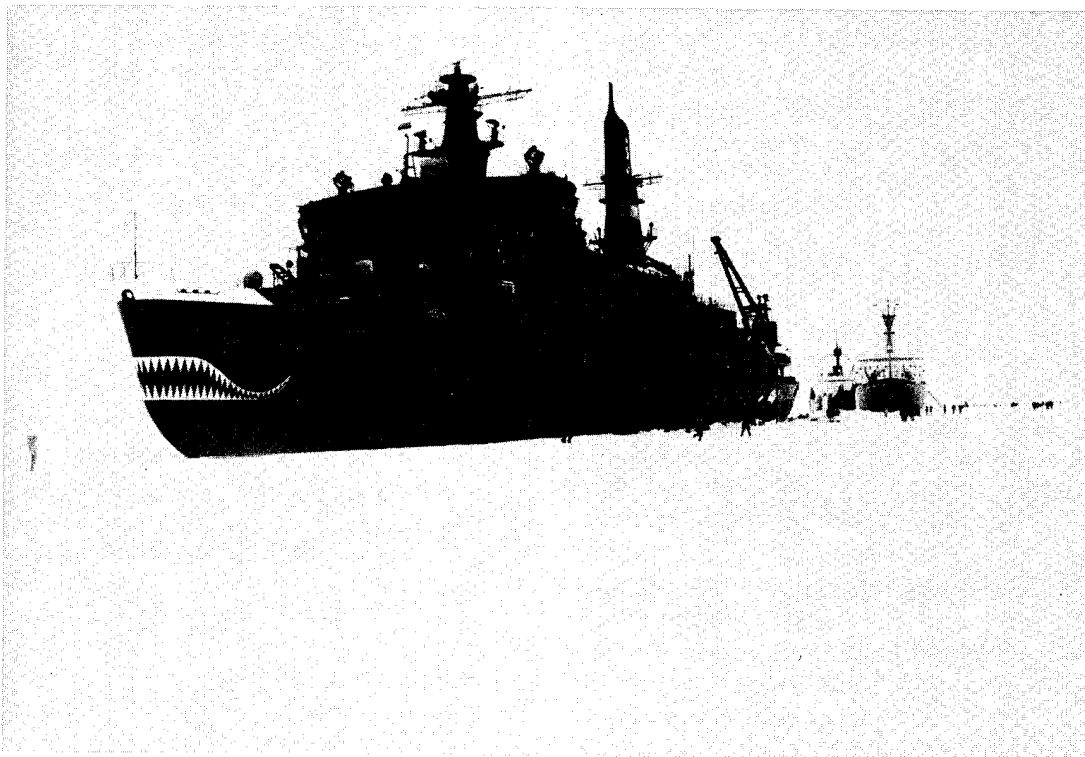
Early history

Johansson et al. (1994) have given an account of the early history of icebreaking ships. Breaking ice with ships was not possible before the advent of steam power. One of the earliest icebreakers, named *Norwich*, was introduced in 1836 on the Hudson River. She had paddle wheels for propulsion and was very effective in breaking ice, remaining in service for 87 years.

By the end of the nineteenth century, only fixed-pitch, screw-type propellers driven with steam power were installed on new icebreakers. Early icebreakers were not powerful, and the hull form was basically adapted from open water hull shapes by sloping the bow angles more to create a vertical force to break the ice in bending. Many innovative designs were proposed and built to increase icebreaking efficiency. For instance, the highly suc-

Table 1. Selected important icebreaking voyages in recent years (after Brigham 1992).

<i>Polar ship/flag</i>	<i>Time of year</i>	<i>Route/location</i>	<i>Significance</i>
<i>Lenin</i> USSR	Summer 1960	Northern Sea Route	World's first nuclear surface ship commences icebreaking escort duties
<i>Manhattan</i> USA	Autumn 1969	Northwest Passage	Experimental voyages to test the feasibility of commercial tankers in the Arctic
<i>Louis S. St. Laurent</i> and <i>Canmar Explorer II</i> Canada	Aug 1976	Northwest Passage	Successful escort of a drill ship from the Atlantic to the Canadian Beaufort Sea
<i>Arktika</i> USSR	Aug 1977	Murmansk to the North Pole and return	First surface ship to reach the geographic North Pole (17 Aug)
<i>Sibir'</i> and <i>Kapitan Myshevskiy</i> USSR	May-Jun 1978	Northern Sea Route (north of Novosibirskiy Islands)	First high-latitude "trans-Arctic" ice escort
Polar icebreakers and icebreaking carriers USSR	Navigation season 1978-79	Barents and Kara seas	First successful year-round navigation from Murmansk to Dudinka on the Yenisey River
<i>Polar Star</i> and <i>Polar Sea</i> USA	1979-86	Bering, Chukchi, and Beaufort seas	Arctic marine transportation ("trafficability") studies around Alaska
<i>Polar Sea</i> USA	Jan-Mar 1981	Bering Sea to Beaufort Sea	First winter transit to Pt. Barrow, Alaska
<i>Polar Star</i> USA	Dec 1982-Mar 1983	Antarctica	First high-latitude (above 60°S) circumnavigation of Antarctica in modern times
<i>Leonid Brezhnev</i> and 12 other icebreakers USSR	Oct-Nov 1983	North coast of Chukotka, Siberia	Rescue of 50 cargo ships trapped in ice
<i>Arctic</i> Canada	Aug 1985	Bent Horn, Cameron Island	First cargo of crude oil from the Canadian Arctic
<i>Vladivostok</i> and <i>Somov</i> USSR	Jun-Sep 1985?	Near Russkaya Station, Hobbs Coast, Antarctica	Rescue of Soviet Antarctic Expedition flagship drifting in heavy ice
Three SA-15 icebreaking carriers USSR	Nov-Dec 1985	Northern Sea Route	Experimental navigation season extension with sailings from Vancouver to Arkangel'sk
<i>Icebird</i> FRG	Fall 1985-Summer 1986	Australian Antarctic stations and Japan to Prudhoe Bay, Alaska	Bipolar resupply operations to Antarctica and Prudhoe Bay
<i>Polarstern</i> FRG	Jul-Aug 1986	Weddell Sea, Antarctica	Winter oceanographic operations
<i>Sibir'</i> USSR	May-Jun 1987	Central Arctic Basin	Evacuate drift station 27 and establish drift station 29; second surface ship to reach the geographic North Pole (25 May)
SA-15 icebreaking carriers USSR	Summer 1989	Europe to Japan via the Northern Sea Route	Soviet arctic carriers under charter to Western shippers for commercial voyages across the top of the Soviet Union
<i>Rossiya</i> USSR	Aug 1990	Central Arctic Basin	Transit to the North Pole (8 Aug) with Western tourists aboard
<i>Arctic</i> Canada	Jun 1991	Northwest Passage to the Polaris Mine, Little Cornwallis Island	Earliest seasonal surface ship transit in eastern reaches of the Northwest Passages; mine reached 23 Jun
<i>Sovetskiy Soyuz</i> USSR	Jul-Sep 1991	Central Arctic Basin and Northern Sea Route	Transit to the North Pole and along the Northern Sea Route with Western tourists
<i>Oden</i> and <i>Polarstern</i> Sweden and FRG	Aug 1991	Central Arctic Basin	International Arctic Ocean Expedition; reached the North Pole on 7 Sep
<i>Sovetskiy Soyuz</i> Russia	Jul and Aug 1992	Central Arctic Basin	Reached the North Pole on 13 Jul and 23 Aug
<i>Yamal</i> Russia	Jul and Aug 1993	Central Arctic Basin	Reached the North Pole three times on 13 Jul, 8 and 30 Aug
<i>Yamal</i> and <i>Kapitan Branitsyn</i> Russia	Jul 1994	Central Arctic Basin	Reached the North Pole on 21 Jul
<i>Yamal</i> Russia	Aug 1994	Central Arctic Basin	Reached the North Pole on 5 and 20 Aug
<i>Louis S. St. Laurent</i> and <i>Polar Sea</i> Canada and USA	Aug 1994	Trans-Arctic Ocean Bering Strait to Svalbard	Reached the North Pole on 22 Aug; encountered <i>Yamal</i> at the North Pole



a. Near the North Pole.



b. View from Yamal (Polar Sea is last in line).

Figure 1. The Russian icebreaker Yamal, the Canadian icebreaker Louis S. St. Laurent, and the U.S. icebreaker Polar Sea during the expedition to the North Pole in August of 1994 (photos courtesy W. B. Tucker, III).

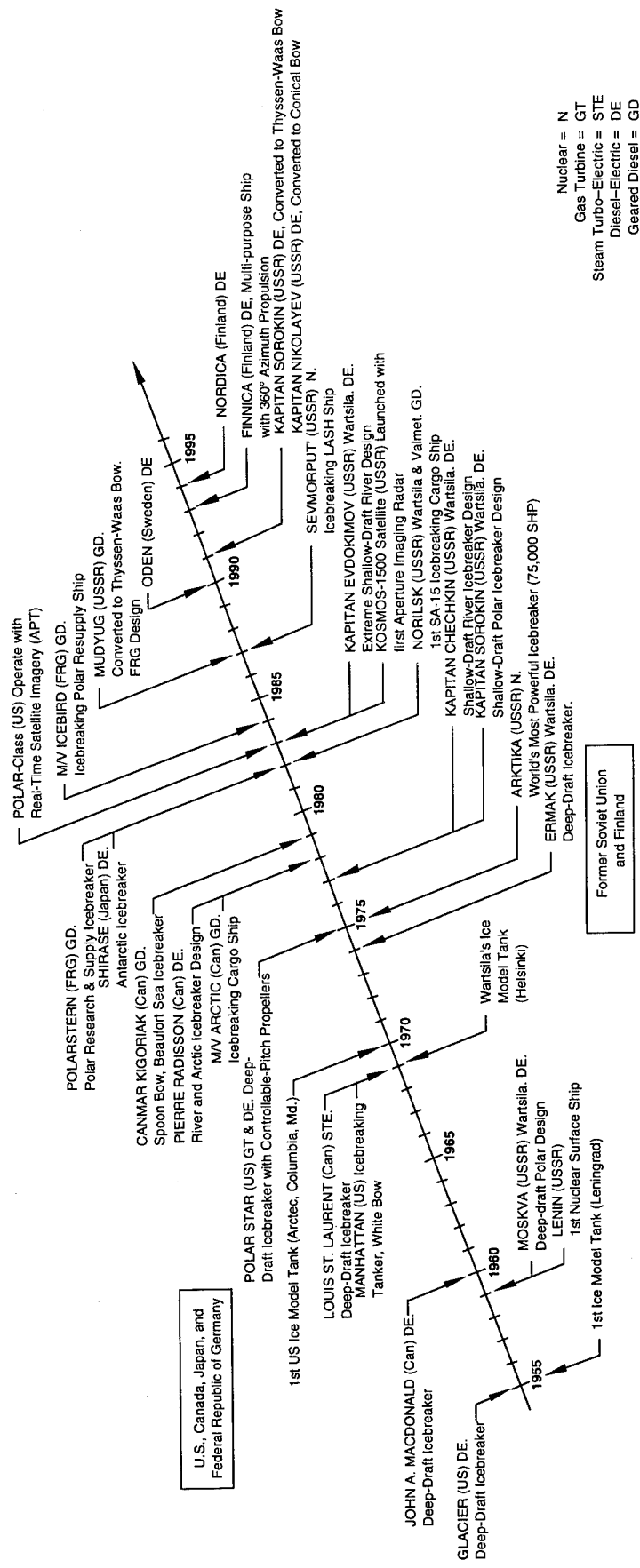


Figure 2. Significant events in the development of polar ship technology since 1955 (after Brigham 1987).

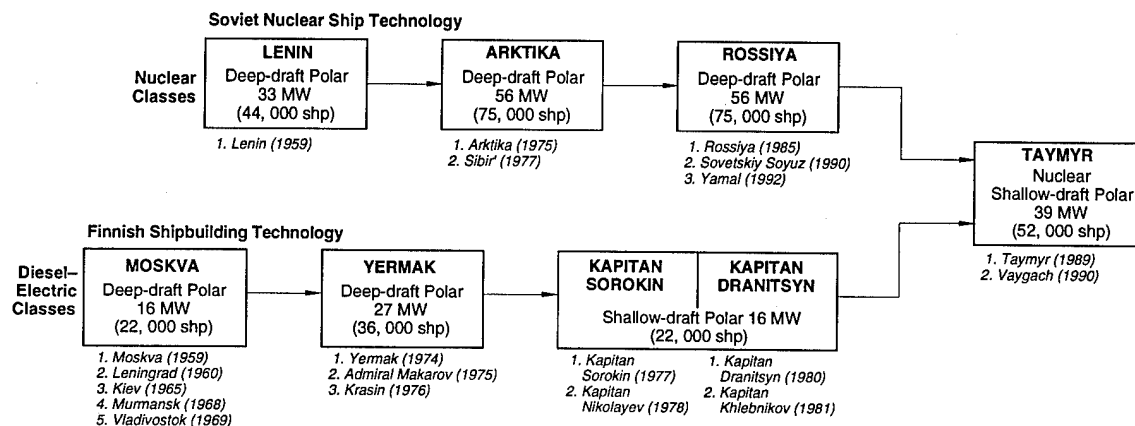


Figure 3. Design evolution of Russian polar icebreakers (after Brigham 1991).

cessful "spoon-shaped" bow was first proposed and built by Ferdinand Steinhaus of Hamburg in 1871. In 1892, Weedermaan invented and patented a device to be placed in front of a ship having a bow not suitable for icebreaking on its own. These devices are still used on Dutch rivers and canals.

By 1900, it was well understood that, while ships with blunt bows are efficient in breaking level ice in sheltered areas, such as rivers, lakes and other protected areas, their performance in rubble ice is poor because they have a tendency to push broken ice ahead of themselves. On the other hand, ships with wedge-shaped bows and sharp stems did not have any tendency to push rubble ice. This experience led to all sea-going ships built between 1901 and 1979 having a wedged-shaped bow and a sharp stem (Johansson et al. 1994). Over the years, the wedge-shaped bows became known as "conventional" bows, and the other shapes as "unconventional" bows.

The development of the bow form remained stagnant in the early and middle part of the 20th century (Johansson et al. 1994). This can be attributed partly to other priorities caused by the two World Wars and by the slowdown of economic activity during the large-scale recession of the 1930s. Despite this stagnancy in bow design, other innovations were introduced during this time. The Russian icebreaker *Yermak*, built in 1899 and fitted with propulsive machinery of 7.46 MW (10,000 hp), had considerable effect on the icebreaking technology at the turn of this century by becoming a pioneer in many untested offshore areas. In 1933, diesel-electric propulsion was introduced on the Swedish icebreaker *Ymer*. In 1947, twin bow propellers were introduced on the Canadian ice-breaking ferry *Abgeweit*. (However, the use of bow propellers has now been discontinued because of their interference with ice.)

Recent history

Figure 2 shows a summary of significant advances in the polar ship technology during the past four decades, as outlined by Brigham (1987), made by Finland and the former Soviet Union, and by the U.S., Canada, Germany and Japan. Together, Finland and the Soviet Union have made enormous contributions to the development of polar ships.

The Soviet Union first used nuclear technology to power the icebreaker *Lenin*, which was built in 1959 with a propulsive power of 29 MW (39,000 hp). The Finnish shipbuilder, Wärtsilä Shipyard (now Kvaerner Masa-Yards), built many icebreakers for the Soviet Union and created extensive design evolution during the years of the development of conventionally powered icebreakers. Recently, these two technologies have merged, as shown in Figure 3, to develop the *Taymyr*-class (Fig. 4), shallow-draft polar icebreakers built in Helsinki with Soviet nuclear propulsion systems installed in St. Petersburg.

Similarly, developments in the U.S. and Canada have contributed to changes in key areas of icebreaking technology (e.g., hull and bow form, gas turbines, and controllable-pitch propellers). In 1969, the U.S. modified tanker *Manhattan* had tenfold the displacement of earlier icebreakers, giving her great ramming capability. In the early 1980's, modern hull and propulsion technologies were also applied to Antarctic ships (e.g., Japan's *Shirase*, and Germany's *Polarstern*). The bows of three icebreakers were converted to the newly developed Thyssen-Waas bow: *Max Waldeck* in 1980, *Mudyug* in 1986 and *Kapitan Sorokin* in 1991. The results of full-scale trials in open water and in ice indicate that this change in the bow of *Mudyug* has increased her icebreaking capability in level ice at reduced power requirements (Milano 1987). However, there were problems with wave slam-

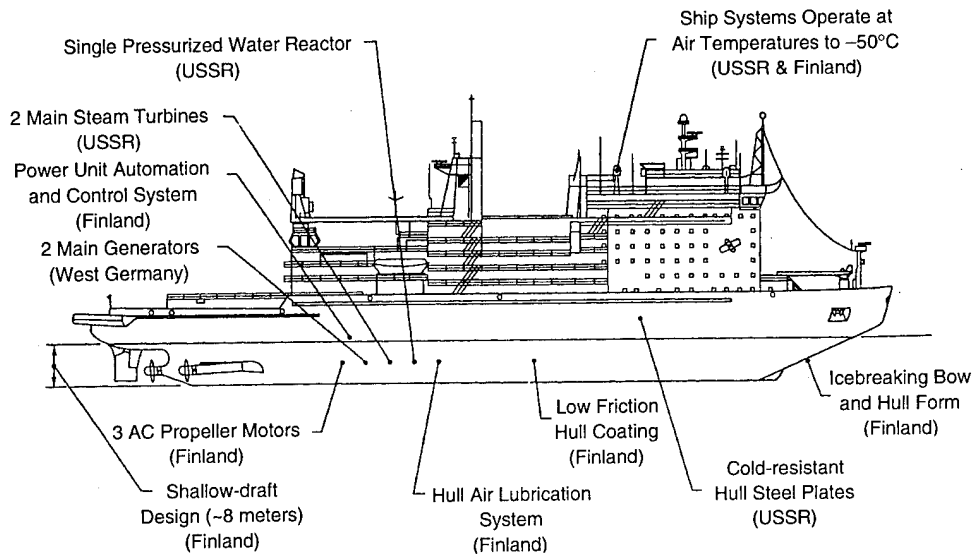


Figure 4. Taymyr-class shallow-draft nuclear icebreaker (after Brigham 1991).

ming in open water operations during high seas, and with the front of the ship pushing rubble ice (Ierusalimsky and Tsoy 1994).

In 1979, the Canadian icebreaker *Kigoriak* was built with a spoon-shaped bow for operations in the Beaufort Sea. Extensive full-scale experience indicated that even this modern version of the spoon-shaped bow was not immune to the ice-pushing problem. However, these problems were solved by using epoxy paint and a water-deluge system to reduce friction between the broken ice pieces and the hull. The water-deluge system lifts several tons of water every second and pours it on top of the ice in front of the bow. This helps to move the ice pieces past the ship by submerging them. In the early 1980s, several ships in Canada were built with spoon-shaped bows. Some of the recent icebreakers built in Europe have also been built with these bows, e.g., the Swedish icebreaker *Oden*, built in 1989, the Russian icebreaker *Kapitan Nikolayev*, converted in 1990, and the Finnish icebreakers *Finnica* and *Nordica*, built in 1993 and 1994.

With the introduction of low-friction coatings and auxiliary systems, the capabilities of present icebreakers are greatly enhanced so that they can make steady progress in all types of ice conditions. With sufficient displacement, power and auxiliary systems, future icebreakers that can operate independently year-round in the Arctic are well within the known technology and operational experience (Keinonen 1994). As in the past, the construction of future icebreakers and icebreaking cargo ships will be closely linked to economic conditions and pressures. Choices between dedicated

icebreaking ships and multi-purpose ships will be dictated by the needs of future developments and trade.

INVENTORY OF ICEBREAKING SHIPS

Icebreaking ships that will be built in the future may have their designs based on the present state of icebreaking technology and may also incorporate innovative developments in many areas of marine technology. Past experience can help designers avoid mistakes, but accepting the present status too rigidly can also discourage them from innovation. Improvements in the design of icebreakers should result from a full understanding of the current status of icebreaking technology.

Information on most of the icebreaking ships in the world is given in the appendix of the review paper by Dick and Laframboise (1989), and an updated and a modified version of this list is also included in the appendix of a report by Mulherin et al. (1994). The latter database contains information on icebreakers and icebreaking cargo ships from the following countries: Argentina, Canada, Denmark, Finland, Japan, Sweden, United Kingdom, Russia (or former Soviet Union), U.S. and Germany.

An inventory of all ships that are capable of navigation in at least 0.3-m- (1-ft-) thick ice has been prepared for this study. This information has been assembled in an electronic database and is also presented in Appendix B. The database con-

tains technical and other forms of information on each series of ships. Technical information consists of length, beam, depth, draft, deadweight, displacement, propulsion machinery, nominal speed, bow shape, propulsion power, fuel capacity, fuel rate, etc. Non-technical information consists of the name (or former name), names of sister ships, ownership, shipyard and year of construction, home port, ice classification, etc.

SIZES AND DIMENSIONS

The main dimensions of a polar ship are its length, beam width and depth. The draft is the depth of the ship's keel below the waterline, whereas the depth is the distance between the keel and the deck. The depth of water in which a ship can operate without touching bottom depends on the draft. Figure 5a shows plots of the dimensions of icebreakers (cargo ships not included) as compiled by Dick and Laframboise (1989), whereas Figure 5b shows the dimensions of all ships as compiled in the database given in Appendix B. The scatter in the plot of data in Figure 5b is greater than that in Figure 5a, because ships listed in Appendix B are not only icebreakers but also other ships having some icebreaking capability. The trends of the lines shown in Figure 5a pertain only to icebreakers, whereas the lines of best fit shown in Figure 5b pertain to the data on vessels listed in Appendix B.

Beam

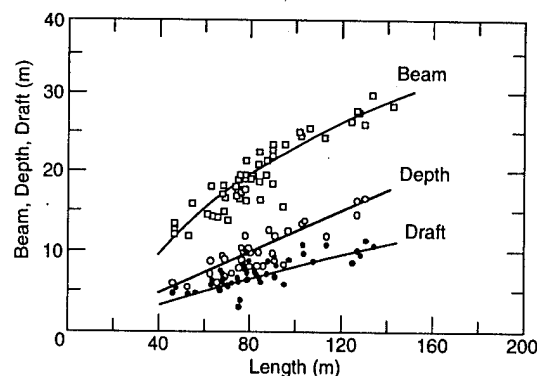
In Figure 5a, the mean length-to-beam ratio of icebreakers varies from 3.6 to 4.6 for lengths from 40 to 140 m respectively. North American vessels are narrower than those from Finland, Sweden and Russia. This may be attributed to the practice of convoy escort used in the Baltic Sea and Russian Arctic. The line of best fit in Figure 5b has an intercept of 6.7 m and a slope of 0.102 m/m.

Depth

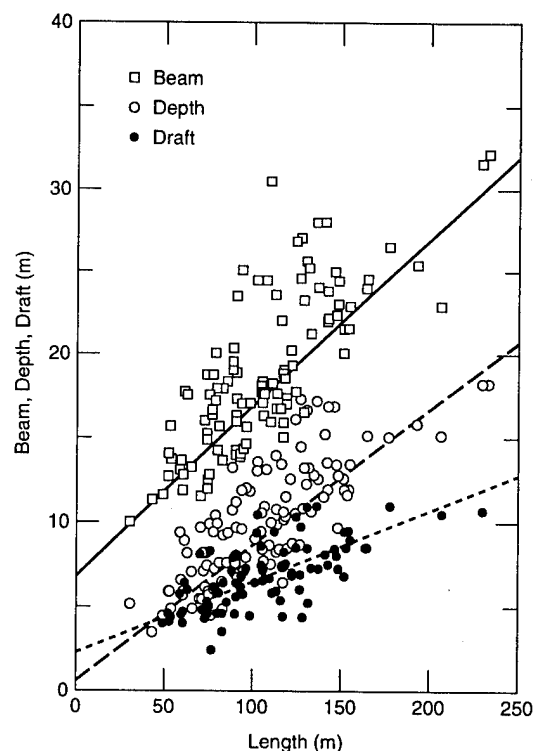
In Figure 5a, the mean length-to-depth ratio of icebreakers varies from 8.9 to 8.2 for lengths from 40 to 140 m respectively. This ratio is high for supply vessels and low for conventional icebreakers. The line of best fit in Figure 5b has an intercept of 0.6 m and a slope of 0.08 m/m.

Draft

In Figure 5a, the mean length-to-draft ratio of icebreakers varies from 11.4 to 12.2 for lengths from



a. Icebreakers (cargo ships not included) (after Dick and Laframboise 1989).



b. All vessels included in the inventory of ships listed in Appendix B.

Figure 5. Dimensions of vessels.

40 to 140 m respectively. Draft, like other dimensions, is usually defined by the operating requirements of the ship. The line of best fit in Figure 5b has an intercept of 2.2 m and a slope of 0.042 m/m.

Maximum deadweight

Figure 6 shows a plot of deadweight at maximum draft vs. the overall length of the vessels listed in Appendix B. The curve shown in Figure 6 is a best fit quadratic curve having the following equation

$$D_{\max} = -4545 + 18.81 L + 0.61 L^2$$

where D_{\max} is the maximum deadweight and L is the overall length of a vessel.

HULL FORMS

The primary consideration for the choice of hull form of an icebreaking ship is the lowest power required to make progress in ice. Power in open water, maneuvering and protection of propellers from ice are some of the secondary considerations. The following are factors that need to be considered while selecting a hull form (Dick and Laframboise 1989):

1. Performance in ice of all types.
2. Performance in open calm water.
3. Performance in heavy weather in open water.
4. Maneuvering capability.
5. Overall dimensions.
6. Ease and cost of construction.
7. Ease of repair and type of ship (e.g., cargo, icebreaker, etc.).

Because some of the objectives listed above are in conflict with each other, the best hull shape is one that takes into account the overall operations of a vessel. Most of the sea-going icebreaking ships have been constructed with conventional bows. However, there have been a few departures from this trend in the recent past, and a few ships have been built with unconventional bows out of par-

ticular considerations of costs, icebreaking efficiency or maneuvering. Auxiliary systems have to be furnished so that a ship with an unconventional bow can operate effectively in rubble ice as well as in level ice.

Bow shape

The bow shape of an icebreaker is characterized by five basic design features, shown in Figure 7. Flare angles contribute to the efficiency of icebreaking and ice block submergence, whereas waterline angles contribute to clearing efficiency. Buttock angle and stem angle are associated with the flare and waterline angles, and these also contribute to breaking and submergence efficiencies.

The progression in the design of icebreaker bows over the last two decades has been to increase flare angles, to reduce waterline angles and to reduce stem and buttock angles (Dick and Laframboise 1989). These changes have resulted from a systematic series of model tests to produce a more efficient icebreaking bow. Over the years, the values of stem angles of icebreakers have decreased from 30 to 20°.

The selection of bow shape is greatly influenced by the mission profile of a polar ship. Different bow shapes that have been used are shown in Figure 8 (Dick and Laframboise 1989), and a brief discussion of each follows.

Straight stem with parallel buttocks

This shape has been commonly used for Soviet and Finnish icebreakers since the 1950s, as dem-

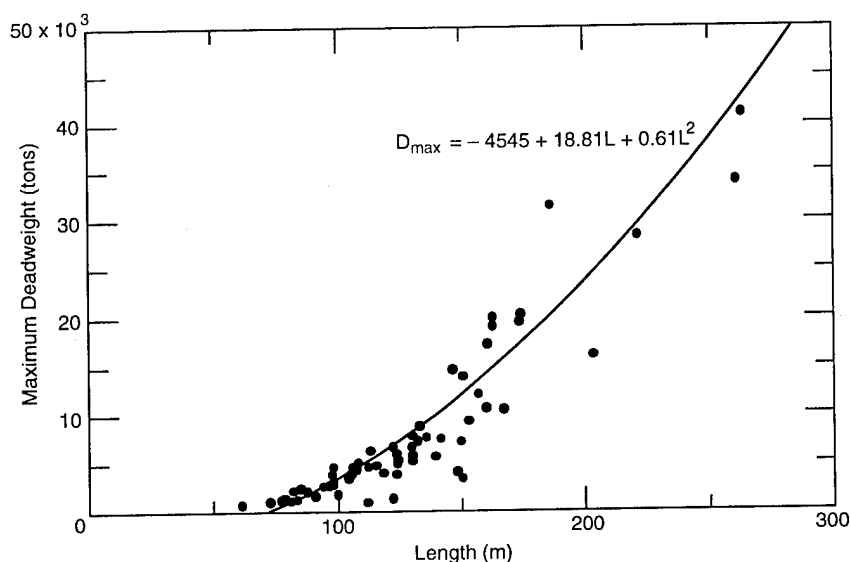


Figure 6. Maximum deadweight vs. overall length of all vessels listed in Appendix B.

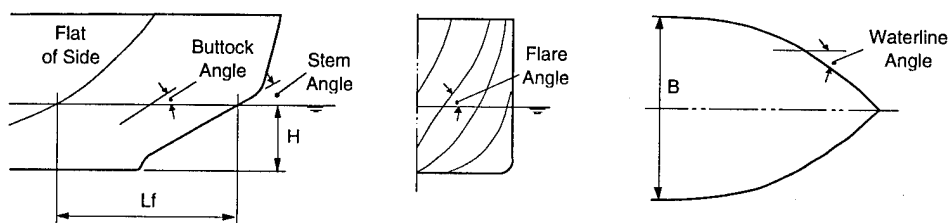


Figure 7. Main features of bow forms (after Dick and Laframboise 1989).

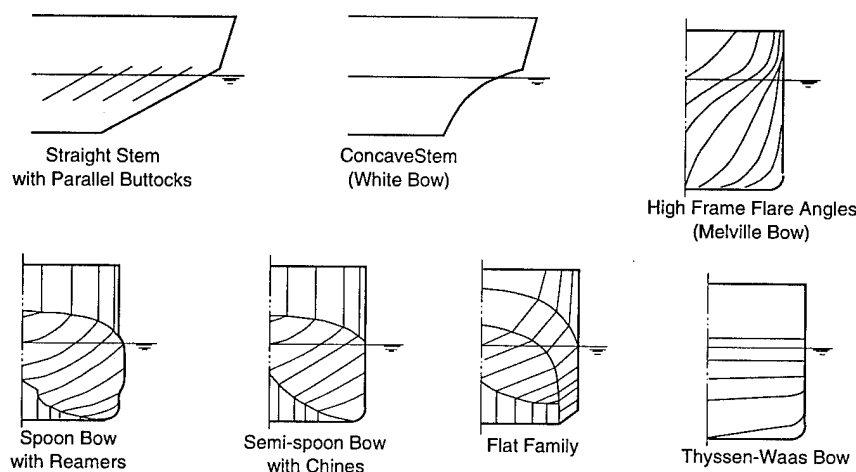


Figure 8. Different shapes of icebreaking bows (after Dick and Laframboise 1989).

onstrated by the *Moskva*-class icebreakers in the 1960s, and the *Urho*-class Baltic icebreakers in the 1970s.

Concave stem (White bow)

Although the concave stem had been used in earlier icebreakers, R. White developed this particular shape in 1969 for efficient icebreaking and ice clearing. This bow shape was used in the U.S. icebreakers *Polar Star* and *Polar Sea*, built in the mid-1970s, in the Canadian icebreaking cargo ship *Arctic*, built in the late 1970s, and in the Canadian R-class icebreakers, built between 1978 and 1984. Because of the concave stem, this bow shape has higher frame flare angles close to the stem.

High flare angles (Melville bow)

This shape was developed to reduce the icebreaking component of ice resistance. Recently, the Canadian icebreaking cargo ship *Arctic* was modified to this type of bow, and its performance increased from 1 to 4 m/s (2 to 8 knots) in 1-m-thick ice.

Spoon bow with reamers

The spoon-shaped bow has been more efficient because this shape allows a constant frame flare angle throughout the bow length. As mentioned earlier, this shape was used in the past, but its use was discontinued because of its high resistance in heavily snow-covered ice, and its tendency to push broken ice in front of the ship. With the introduction of bubbler systems or water wash systems, these problems have been overcome.

A modification of this shape was reintroduced on the Canadian icebreakers *Canmar Kigoriak*, built in 1979, and *Robert Lemeur*, built in 1981. The extended beam at the shoulder (reamers) with the abrupt change in shape eliminates midbody resistance by cutting a wider channel in ice, but it causes extra resistance in open water. Recently, this shape was also used in the European icebreakers *Oden*, *Kapitan Nikolayev*, *Finnica* and *Nordica*. The hull form of the Finnish multipurpose icebreakers *Finnica* and *Nordica* is shown in Figure 9, which also shows the icebreaking stern and the bi-directional reamers on the sides.

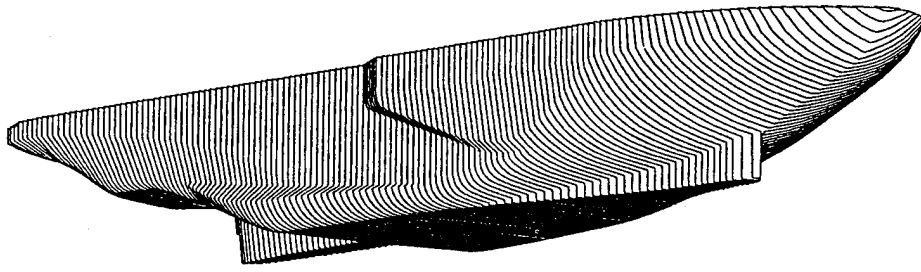


Figure 9. Hull form of the Finnish multipurpose icebreakers *Finnica* and *Nordica* (after Lohi et al. 1994).

Semi-spoon bow with chines

This shape is similar to the spoon bow shape, except that the extended beam (reamers) are replaced by shoulder chines. This shape has been used on vessels working in the Beaufort Sea, and it has improved icebreaking performance. But it has had some detrimental effect on the open-water resistance.

Flat family

These shapes are similar to the spoon bow and semi-spoon bow shapes, except that flat plates have been used to reduce the construction costs. This shape was developed as a compromise between icebreaking capabilities and construction costs. This type of bow has been used on the Canadian vessels *Arctic Nanabush*, built in 1984, and *Arctic Iwik*, built in 1985, both being used for ice management in the Beaufort Sea.

Thyssen-Waas bow

This type of bow shape is a significant departure from a conventional icebreaking bow. The bow first breaks the ice by shearing at the maximum beam of the ship, and then breaks the ice in bending across the front of the bow. This shape is characterized by flat waterlines at the extreme forward end, extended beam, a low stem angle with an ice clearing forefoot, and high flare angles below the waterline. The ice clearing capability is so good that the channel behind the ship is about 85% free of ice. As mentioned earlier, the vessels that have been fitted with this type of bow are the *Max Waldeck* (1980), the *Mudyug* (1986) and the *Kapitan Sorokin* (1991).

Of the seven bow shapes listed above, the first three can be called "conventional" or "traditional," because these shapes retain the smooth hull, which offers the least resistance in open water. The other four shapes are "unconventional" or "nontraditional," in that these shapes are a distinct departure

from the smooth hull shapes. Each shape has some benefits and some drawbacks. Therefore, the selection of a bow shape should be based on a full understanding of the operational requirements of a ship.

Midbody shape

The midbody shape of a polar ship is characterized by three parameters: flare angle, parallel sides and longitudinal taper (Dick and Laframboise 1989). The objective of midbody flare is to decrease the resistance caused by it while passing through the channel broken by the bow. Some of the icebreaking cargo ships have a long, parallel midbody. Some of the icebreakers have forward shoulders to break a wider channel to eliminate any ice resistance from a parallel midbody. Similarly, a midbody with longitudinal taper eliminates ice resistance aft of the forward shoulders. This shape has been used on barges pushed by small tugs that operate in sheltered water. The drawbacks of longitudinal taper in the midbody are higher construction costs and an increased probability of getting stuck in pressured ice. A longitudinally tapered midbody is not used on icebreakers or icebreaking cargo ships.

Stern shape

All icebreakers must move astern in ice. Some icebreakers may move back only in the previously broken channel or in broken ice. But there are those icebreakers providing a support role that must break ice while moving astern. Depending upon the mission profile, these ships may have an ice breaking-deflecting stern shape, as shown in Figure 9. The main concern while moving astern is the ingestion of ice blocks into the propellers. Despite many innovative stern designs and shrouded propellers, there is still considerable interaction between ice and propellers (Dick and Laframboise 1989).

Icebreaker performance with different hull forms

Ierusalimsky and Tsoy (1994) presented the results of full-scale tests conducted on three Russian sister ships of the *Kapitan Sorokin* series with different hull forms: *Kapitan Sorokin*, converted to a Thyssen-Waas bow in 1991, *Kapitan Nikolayev*, converted to a conical bow (similar to the spoon-shaped bow) in 1990, and *Kapitan Dranitsyn*, still with the original, wedge-shaped bow. The data on the performance of these ships were obtained over 3 years, enabling a determination of any cost saving resulting from the conversion to bows of different shapes.

For breaking a level ice sheet in forward motion, Figure 10 plots ship performance in terms of the continuous speed of these three ships in equivalent ice thicknesses. The plots in Figure 10 show that *Kapitan Sorokin* with the Thyssen-Waas bow has the best icebreaking capability among the three in level ice, closely followed by the *Kapitan Nikolayev* with the conical bow. The performance of these two ships is much better than that of *Kapitan Dranitsyn* with its original bow. While breaking a channel in fast ice, *Kapitan Sorokin* left up to 40% of the ice in the channel behind it, whereas the other ships left 80–90% of the channel filled with ice. A similar test for backward motion in level ice revealed their performance in reverse order as that for forward motion.

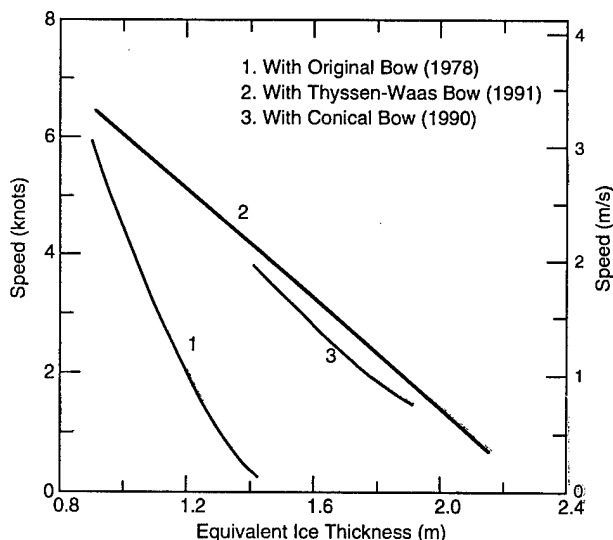


Figure 10. Icebreaking capabilities of three sister ships with different bow shapes in terms of speeds in level ice of different thicknesses at a power level of 16.2 MW (after Ierusalimsky and Tsoy 1994).

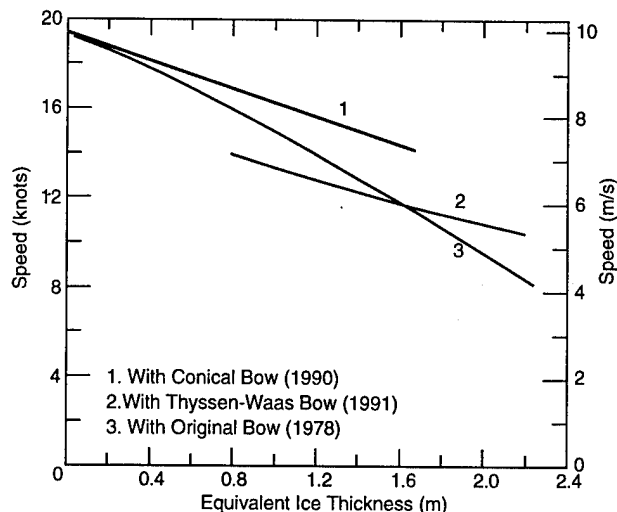


Figure 11. Ship speed vs. equivalent ice thickness during tests in broken ice with three sister ships having different bow shapes. The ships were tested in their own channels (after Ierusalimsky and Tsoy 1994).

Figure 11, giving the results of the tests conducted in freshly broken ice in their own channel, shows that the performance of *Kapitan Nikolayev* is better than that of the other two ships. For tests conducted in broken ice in old channels, *Kapitan Nikolayev* performs better than *Kapitan Dranitsyn*. In old channels full of broken ice, *Kapitan Sorokin* had a tendency to push broken ice ahead of itself when it was not able to reach a speed of 3–4 knots (1.5–2 m/s). Three rounded knives in the bow of *Kapitan Sorokin* work efficiently to break level ice, but they also obstruct the flow of broken ice underneath the bow. At times, the buildup of an ice pile can bring the ship to a standstill, and force it either to ram through the pile or to seek a new path. While operating in drifting broken ice at speeds up to 3–4 knots, *Kapitan Sorokin* showed tendencies to push ice. The performance of *Kapitan Nikolayev* improved in drifting ice fields.

Both ships with the Thyssen-Waas and conical bows must reduce speeds in severe seas because of considerable wave slamming in a head sea, resulting in longer travel times.

Ierusalimsky and Tsoy (1994) have compared the cost savings as a result of conversion of bow shapes from conventional to the two types of unconventional shapes. According to them, *Kapitan Nikolayev*, with the conical bow, had reduced operational costs and increased profitability, whereas similar measures for *Kapitan Sorokin*, with the Thyssen-Waas bow, were less favorable than those for the ship with the original bow. It should, how-

ever, be noted that *Kapitan Nikolayev* is fitted with stainless steel compound plate in the ice belt area, which may be effective in reducing the chances of getting stuck in ice.

STRUCTURAL DESIGN OF POLAR SHIPS

Structural design involves the selection of material and sizes of plates and frames for maintaining the structural integrity of a polar ship under loads from waves and ice during its normal operation (Dick et al. 1987). As a result of research and experience, much has been learned about the nature of ice loads and the mechanics of ice failure. Full-scale measurements of ice loads on many ships have yielded an empirical description of ice forces and pressures that is used in design. The magnitude of ice loads, the existence of significant damage and the emergence of affordable nonlinear finite element analysis packages have together led to the wide use and acceptance of plastic design (plastic design allows some deformation of the structure under extreme ice loads).

Classification of polar ships

All commercial vessels, including most icebreakers, but excluding government-owned vessels, are classified according to the rules developed by six classification societies: Lloyds Register (LR), Det norske Veritas (DnV), American Bureau of Shipping (ABS), Bureau Veritas (BV), Germanischer Lloyd (GL), and Russian Register of Shipping (RS). Besides the rules of the classification societies, there are three national sets of rules to control navigation in ice-covered waters: Finnish-Swedish, Russian and Canadian. The classification of a vessel is used for insurance and to comply with the international regulations, such as the Safety of Life at Sea (SOLAS) and prevention of pollution. Government-owned vessels are also surveyed for compliance with recognized national and international standards.

The classification societies are responsible for approving the design and supervising the construction of individual vessels to ensure conformity with the standards set by international conventions and by the classification of that vessel. The vessels are subjected to annual and special surveys throughout their lives (Toomey 1994).

The ice classification of a vessel depends on its capability to resist damage while navigating in ice

under normal handling conditions. Unfortunately, there are so many classifications by the different societies that it is difficult to establish equivalency among them (Santos-Pedro 1994, Toomey 1994). A limited equivalency among the ice classifications of the various societies is given in the Appendix A of a companion report by Mulherin (1994). At present, an effort is underway to standardize ice classes as international navigation through Arctic routes, such as the Northern Sea Route and the Northwest Passage, becomes more attractive for shipping products between the North Atlantic and the North Pacific (Santos-Pedro 1994). While comparing the ice-strengthening requirements according to the Russian Register Rules and Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR), Karavanov and Glebko (1994) have presented an extensive comparison of the ice loads, section modulus and shear area of frames, and thickness of shell plating. The new CASPPR (1989) regulations call for smaller scantlings and thinner shell plates than those required by Russian Rules because CASPPR allows a certain amount of plastic deformation of the structure under extreme ice loads.

Ice loads and pressures

Compression of ice at low strain rates results in creep deformation with or without micro-cracking. The constitutive relations between stress and strain for creep deformation at low strain rates are well known. At higher strain rates ($>10^{-3} \text{ s}^{-1}$), the ice fails in a brittle manner, resulting in instabilities caused by macro-cracking. The failure mechanism for brittle failure has not been fully understood. Failure loads or pressures also depend on the state of stress, e.g., uniaxial vs. multiaxial. At present, the dependence of compressive failure of ice under multiaxial loading at different strain rates is being studied by researchers all over the world (e.g., Frederking 1977, Richter-Menge et al. 1986, Smith and Schulson 1994, etc.).

There have been attempts made to relate the forces exerted on a ship or a structure by crushing of ice to the uniaxial compressive strength of ice, but these attempts to obtain empirical relationships through the use of many coefficients have not been fruitful. Although much has been known about the forces from flexural failure and compressive failure of ice at low strain rates, the understanding of brittle failure is still incomplete at high rates of loading and in a multiaxial state of stress. Results of small-scale indentation experiments on freshwater ice indicate that brittle failure is activated at

high rates of indentation, resulting in nonsimultaneous contact between the ice and the indenter.

Design values are taken from empirical relations obtained from full-scale measurements of ice pressure. The data on effective pressures obtained from full-scale measurements during ice-ship and ice-structure interactions (Masterson and Frederking 1993) are plotted with respect to contact area in Figure 12, and these data provide empirical values for effective pressure to be used in design.

Materials

Considerable effort has been devoted by classification societies and regulatory authorities to the selection of steel grades suitable for use in the structure of ships that are exposed to very low tempera-

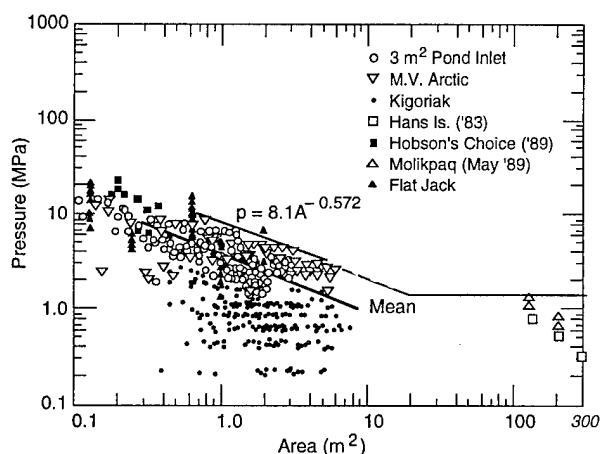


Figure 12. Measured effective pressure vs. contact area (after Masterson and Frederking 1993).

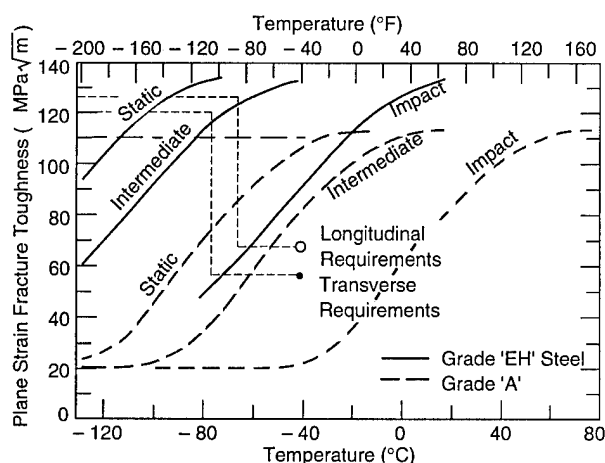


Figure 13. Plane strain fracture toughness vs. temperature for two grades of steel ("A" and "EH") (after Dick et al. 1987).

tures. The fracture toughness of steel depends on the operating temperature and on the rate of loading. In Figure 13, the plane strain fracture toughness of two types of steel has been plotted with respect to temperature for three rates of loading.

Steel fractures in a brittle manner, without any warning of impending failure, when the stresses are of sufficient magnitude to propagate a crack from a flaw or small crack in the material. The criterion for crack propagation in linear elastic fracture mechanics is that an existing crack will grow when the stress intensity factor at the crack tip is greater than the fracture toughness of the material. For nonlinear material behavior, the causes for brittle fracture have now been established, and the relationships among the cause of fracture, the toughness of the material, the flaw size and shape, the loading rate of the structure, and the temperature are understood. From this understanding, materials and welding techniques have been developed to increase the reliability of ship structures. It is the consensus of many operators that the steel used in the present generation of polar ships is mostly adequate (Dick et al. 1987).

There are currently two procedures for specifying the type of steel to be used in different parts of a ship: "design by rule" and "design by analysis." Design-by-rule procedures require the designer to consider service temperature and to select steel grades that have adequate notch toughness. Design-by-analysis procedures require the designer to consider the magnitude and the rate of loading that may be applied during the life of a component, and to design that component with adequate reliability according to its importance. The design-by-analysis approach places a large responsibility on the designer, but it may provide a more reliable and economical design than that by the design-by-rule approach.

The midbody region of a ship will experience vibrations excited by shocks at the bow, but the vibratory stresses have much longer rise time than shock-induced stresses, resulting in small chances of initiating a fracture. However, the static stresses from vibrations may be high enough to cause fracture in the primary structure of a ship. Ships have experienced brittle fracture in the midbody region, and because damage in this area is potentially more catastrophic than damage to the bow, materials and welding techniques should prevent both crack initiation and propagation. Because small cracks and defects in a material are inevitable, the material selected must have crack arrest properties to stop crack propagation.

Welding

After selection of steel, welding is the next most important component in the reliability of the structure of ships (Dick et al. 1987). Welds in ships must withstand the corrosive effects of seawater, stresses caused by cargo, icebreaking operations and wave-induced motions. The biggest variable in welding technology is the skill of the welder, especially when working in confined spaces. To determine the reliability of a structure, the designer of a ship must take into consideration the flaws in the material as well as in the welds. The importance of quality control in welding can be assessed from the statistics that 95% of all defects in a structure originate from defects within the welded zone.

The fracture toughness of a weld depends on the method of weld deposition, including the rate, the number of passes, heat input and electrode size. The variations in weld toughness may be larger than those of the parent materials. Caution should be exercised not to degrade the toughness properties of a weld by using large electrodes and fast rates of deposition in the interests of cost saving. Research on reducing the accelerated corrosion of welds is under way in different parts of the world.

Plating

The plating contributes the largest component to the structural weight of most ships and, together with the frames and the stringers, it forms the stiffened panels that resist the loads on a ship (Dick et al. 1987). While the weight of a ship can be reduced by reducing the plate thickness and by increasing the framing, this increases the cost of fabrication.

When a rectangular plate supported by frames on four sides is loaded by uniform pressure that acts perpendicular to its surface, the deflections and the stresses in the plate can be calculated by the small deflection theory of plate bending, as is usually done for structural analysis. This theory ignores the membrane stresses that develop because of large deflections and yielding of the material. As a result of ignoring the membrane action, the load carrying capacity estimated from small deflection theory is small compared to those obtained from large-deflection theories and experiments.

Figure 14 shows plots of load vs. deflection obtained from experimental results and two plastic analyses—one that considers elastic flexure followed by formation of three plastic hinges without any membrane action, and the other that considers only ideal plastic membrane action. The loads in the plots have been made nondimensional

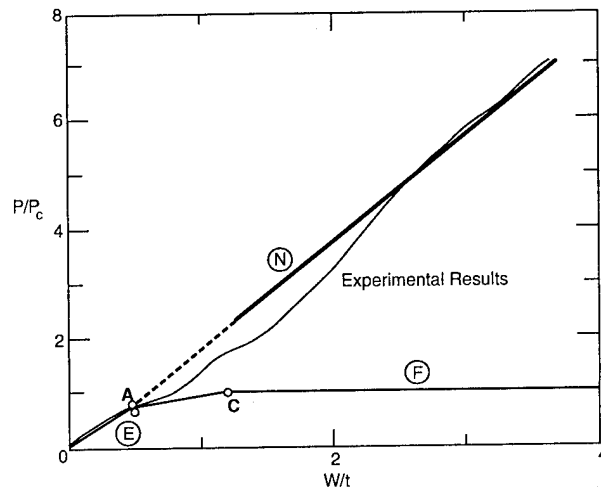


Figure 14. Pressure vs. deflection, showing domains of different behaviors from small to large deflection (after Ratzlaff and Kennedy 1986). Along the vertical axis, the applied pressure P is made nondimensional by P_c , the pressure at which collapse (point C) is assumed to take place by formation of three hinges without membrane action. Along the horizontal axis, the maximum deflection W is made nondimensional by the plate thickness t . The curve labeled E represents elastic flexure with an elastic membrane up to the complete formation of an edge hinge. The curve labeled F represents elastic flexure without membrane action, followed by the formation of the first hinge and then three hinges. The curve labeled N represents ideal membrane action.

with respect to the collapse load predicted by the formation of three hinges without membrane action, and the deflection is made nondimensional with respect to the plate thickness. Figure 14 shows that the curve depicting the experimental load-carrying capacity of a plate is initially close to that predicted by elastic flexure theory for small deflections, and then it approaches that predicted by the plastic membrane action theory for large deflections. This suggests that thick plates form plastic hinges before the membrane action is activated (Ratzlaff and Kennedy 1986).

Framing

The frames support the shell plates and resist the loads on the shell by bending and shear deformation. Inspection of ice-damaged vessels has revealed that failure takes place consistently in the supporting frames rather than the hull plating (Dick et al. 1987, DesRochers et al. 1994). Frames have several components: the shell plate that acts as a flange, a web, an internal flange (optional), end brackets (optional), tripping brackets (optional) and cutouts (optional).

The proposed CASPPR allow a certain amount of plastic deformation of the structure under extreme ice loads, and they provide factors to account for the post-yield buckling of stiffened structures. DesRochers et al. (1994) compared the stability of flat bars with that of angle sections in a stiffened structure. When a structure is designed for buckling according to linear analysis, flat bars are avoided because angle sections have large moments of inertia to resist bending. However, DesRochers et al. (1994) found that the use of flat bar sections increased the stability of the composite structure beyond the yield point of the material, whereas the structural stability decreased with the use of angle sections as yielding progressed through the frame. The structure of the Canadian icebreaking cargo ship *Arctic* has been redesigned according to CASPPR to carry full ice loads without failure.

The Swedish icebreaker *Oden* is the first icebreaker designed according to the technology behind the proposed CASPPR, making it possible to use a large frame spacing of 850 mm instead of the normal 400 mm (Johansson et al. 1994). This has resulted in considerable cost savings in construction. After the voyage of *Oden* to the North Pole, inspection of the structural damage revealed some indents in the shell plating between frame stations 30 and 76 on both sides, and some deformation in the side and bottom frames (flange, web and bracket), but this damage was not serious. The damaged frames were reinforced, but the indents in the steel plates were left as they were (Backman 1994).

PROPULSION SYSTEM

The major components of the propulsion system of an icebreaking vessel, or any ship, are the propellers, shafts, transmission systems and prime movers. The number of propellers varies between one and three. Developments in propulsion systems that have taken place during the last four to five decades are reflected in those of existing icebreakers and icebreaking cargo ships, and these become apparent in the plot of shaft power vs. the year of construction (Fig. 15). Some of the special features of propulsion systems, such as controllable-pitch propellers and mechanical transmissions, nozzles and various electrical transmissions, have been highlighted in Figure 15.

The dc-dc electrical transmission has been commonly used since its introduction on the Swedish

icebreaker *Ymer* in 1933. Although this system is still being used on many icebreakers, new mechanical and electrical transmissions have been introduced on newer icebreakers and icebreaking cargo ships. Since 1966, the number of ships with controllable-pitch propellers and mechanical transmissions is steadily increasing. The Russian LASH vessel *Sevmorput*, delivered in 1986, placed all of its propulsion power on one shaft using a controllable-pitch propeller and mechanical transmission, thus doubling the power transmitted per shaft from 16.65 to 29.42 MW (Fig. 15b).

One of the main reasons to use direct mechanical transmission is to cut down the losses in transmission. Since 1978, propeller nozzles have been fitted to icebreakers to increase thrust and to prevent propeller damage by reducing ice ingestion. Nozzles have been installed on most of the Beaufort Sea ice management-supply vessels, whereas *Polar Sea* and *Polar Star* have operated in ice without nozzles since 1976. Recently, azimuth-mounted propulsion units have been installed on the Finnish icebreakers *Finnica* and *Nordica* and it is

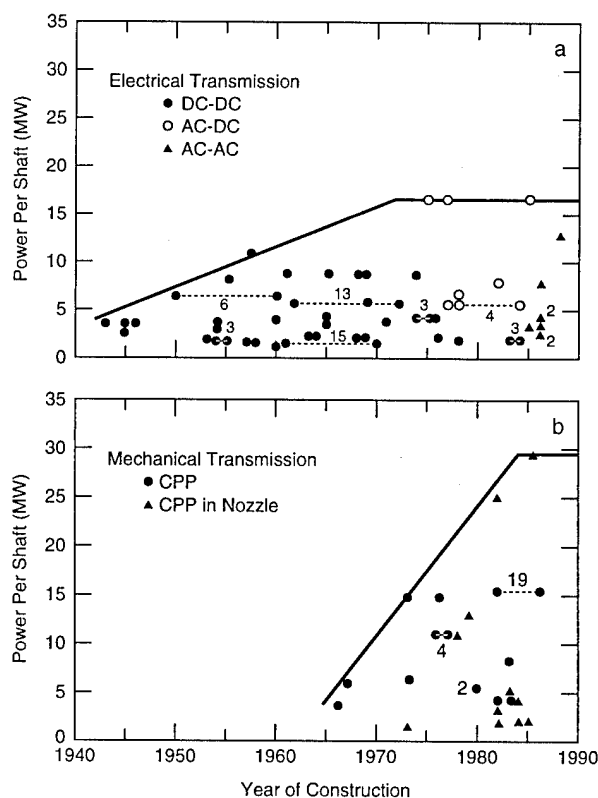


Figure 15. Shaft power vs. year of construction for icebreaking ships: (a) electrical transmission system, and (b) mechanical transmission system (after Dick and Laframboise 1989).

likely that this system will be used in future ships, because it offers good maneuverability in broken and intact ice.

The selection of a suitable propulsion system is based on the intended functions of an icebreaking vessel. The requirements of a propulsion system are:

1. Reliability of full power on demand to navigate safely in the Arctic.
2. Flexibility of operating efficiently and economically in open water as well as in heavy ice at a range of power levels.
3. Maneuverability to allow rapid change of load, speed and power.
4. High power-to-weight ratio to deliver the required power, with machines as compact and light as possible.

While many combinations of prime movers, transmission systems and propellers may be proposed for a given ship, very few particular systems would fit a given mission profile (Dick et al. 1987). Ships requiring a large range of power can be fitted with multiple engines or combined-system installations, which permit the numbers of engines to be run according to the power requirements of various ice conditions, to achieve the best combination of fuel efficiency and performance. In the following sections, a brief discussion is given of each of the main components of a propulsion system.

Propellers

Both fixed-pitch and controllable-pitch propellers have been installed on polar ships. Fixed-pitch propellers have been used for many years, and these are still being installed on most icebreaking ships. However, controllable-pitch propellers have been used on polar ships with increasing frequency since 1966 (Dick and Laframboise 1989). A plot of shaft power versus propeller diameter is shown in Figure 16, where fixed-pitch and controllable-pitch propellers have been identified. The azimuth thruster units installed on the Finnish icebreakers *Finnica* and *Nordica* have fixed-pitch propellers in a nozzle.

The selection of propeller type depends on the propulsion system used. Nonreversing transmission systems, such as diesel-geared or gas turbine-

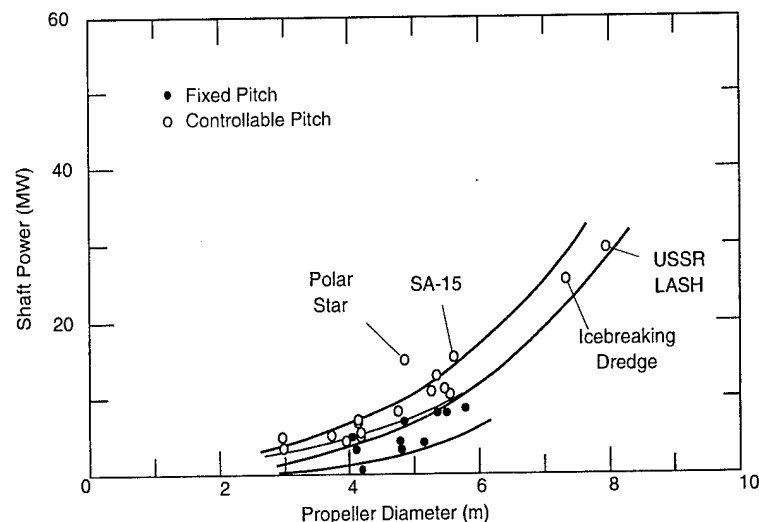


Figure 16. Shaft power vs. propeller diameter for icebreaking ships (after Dick and Laframboise 1989).

geared, may use controllable-pitch propellers to obtain astern thrust and to ease over-torque requirements. Reversing systems, such as any of the electrical systems, may use fixed-pitch propellers because over-torque does not affect an electrical system.

The design requirements of a propeller depend on the mission profile of a vessel. The aspects influencing the design of a propeller are (Dick et al. 1987):

1. Loads and strength requirements.
2. Selection of material.
3. Effects of nozzles.

There are two types of interactions between ice and propellers: ice milling and ice impact. Ice milling takes place when an ice block is large or is trapped between the hull and the propeller. During an instance of milling, ice is either crushed or sheared by the blades, and the loads can be damagingly high. Ice impact is caused by small-size ice pieces that are accelerated through a propeller or thrown out radially and pushed around the edge of the propeller disk. The loads from ice impact are relatively moderate, but it happens more frequently.

For propellers in a nozzle, the chances of ice milling are small, and the magnitude of the loads generated are also small in comparison to those for open propellers. The factors that influence the ice loading on a propeller have been identified, but the ability to determine the ice milling-impact loads is not well developed because of the complex interaction between ice and propellers. The

design of an ice-strengthened propeller must meet the dimensions and the strength requirements of the classification societies.

The material used for the propeller blades of polar ships must have high stress and impact resistance qualities. Stainless steel and bronze are commonly used for ice-strengthened propeller blades. Because stainless steel has a higher erosion resistance and higher ultimate and yield strengths than does bronze, stainless steel propellers have a slender and efficient blade profile. Most of the existing bronze controllable-pitch propellers are operating in nozzles, whereas most stainless steel controllable-pitch propellers fitted to icebreakers are open propellers. For example, bronze has been selected for the propellers of recent Canadian icebreakers, and the open propellers of the U.S. icebreakers *Polar Star* and *Polar Sea* are made of stainless steel.

Propeller nozzles are used to increase the thrust over a range of ship speed, and to protect the propeller from ice. Thus, the nozzles have an indirect influence on the design of a propeller by reducing the load levels and thereby reducing the strength requirements. Ships equipped with nozzles, e.g., *Kigoriak* and *Arctic*, have operated successfully in ice with very few problems. Some of the shallow-draft vessels, however, have occasionally experienced clogging of their nozzles in rubble or ridged ice. Nozzles have been installed on the azimuth-mounted propellers of *Finnica* and *Nordica*, and these are being considered for future high-powered ships.

Shafting

For large icebreaking ships, the diameters of propeller shafts are large because of high power and high torque requirements. The range of diameters of the shafts installed in existing icebreakers is from 380 mm in *Polar Stern* to 980 mm in the Russian SA15 cargo ships. The basis for designing shaft diameter is that the propeller blade should fail before the shafting. The method to calculate the shaft diameter depends on the modulus of the propeller section and on the ratio of the ultimate strength of the propeller blade material to the yield strength of the shaft material. The requirements of hydrodynamic torque and ice-induced torque are specified by the classification societies. Shafts are generally made of forged carbon steel, although in some cases low alloy steel forgings are also used. There is considerable saving in weight when high-strength steel is used.

One of the major problems found with large vessels is the misalignment of the shaft bearings. The sources of the misalignment problem are (Dick et al. 1987):

1. Deflections in the hull.
2. Eccentric thrust on the propellers, which causes bending moments in the shaft.
3. Insufficient axial and radial bearing flexibility.
4. Changes in the height of bearings, gear case or the engine because of thermal expansion.

Dick et al. (1987) have discussed other elements of the shaft line components, such as couplings, seals and bearings.

Mechanical transmission components

The operating speed of steam reciprocating engines and slow-speed diesel engines is low enough that the power can be transmitted directly through a shaft between the engine and a propeller. This is the most efficient form of transmitting power to a propeller, because the only losses incurred are at the bearings. However, most prime movers, such as medium-speed diesel and steam and gas turbines, have an output speed that is too high to obtain the best propeller efficiency. A speed-reducing transmission must be used to deliver power to the propellers at the optimum speed.

As shown in Figure 15b, many icebreakers and icebreaking cargo vessels have been fitted with mechanical transmission of power since 1966. Most of these vessels are driven by one or more medium-speed diesel engines and a set of single-reduction gears, except the Russian LASH, which is driven by a steam turbine. A clutch or fluid coupling is used between an engine and a gear system. In a few icebreakers, flywheels have also been used to smooth out the transient, ice-induced torque.

The gearboxes that are installed on polar ships are within the experience of the manufacturers. The largest gearboxes installed on any icebreaker are those on the U.S. icebreakers *Polar Sea* and *Polar Star*, which are powered by combined gas turbine and diesel-electric systems. The Russian SA15 cargo ships have been fitted with large gearboxes with twin inputs, each delivering 7.5 MW, and connected through fluid couplings to limit overload torque.

Electrical transmission systems

Four types of electrical transmission systems are available for polar ships. These systems are listed according to their chronological order of develop-

ment: dc-dc, ac-ac, ac-dc, and ac-FFC-ac. An ac system is preferred because of its light weight and higher efficiency. The problems of commutation in dc systems are not present in ac systems.

The advantages of an electrical transmission over a mechanical one are that the characteristic of the drive can be exactly matched with the mission profile of a ship, and that the total power for the ship can be divided among a number of engines. There is flexibility in the placement of generators in a ship. An electrical system also isolates the prime mover from the overload torque caused by ice loads on the propellers. The disadvantages of an electrical transmission system are the higher costs, greater weight and larger space requirements.

With medium-speed diesel engines as prime movers, the dc-dc system is most commonly used in icebreakers. The maximum speed of a dc generator must be less than 100 rpm owing to the limited capacity of the commutator brushes to transmit current. The advantages of a dc system are its simplicity, ease of control, good torque characteristics (especially at low speed) and lower cost than other electrical systems. In comparison to mechanical transmission systems, the disadvantages of this system are its higher cost, greater weight and volume, lower transmission efficiency (about 85%) and a relatively high requirement for manpower.

The ac-dc system combines the advantages of ac generators with the precise speed control of dc motors. The generated power, in three-phase alternating current, is converted with low losses to direct current by the use of thyristors, which were developed in the 1960s.

The ac-ac propulsion system is based on synchronous motors. The speed is changed by changing the speed of the prime mover. It is the simplest and least expensive. This system, while perhaps being the economical choice for open water ships, is not suitable for icebreaking ships. The generator and the motor may fall out of synchronization when the propellers are subjected to large ice loads. Other disadvantages of this system are the low torque at start up and the excitation of resonant vibrations.

The ac-ac system with Full Frequency Control (FFC), or a cyclo-converter, is the most suitable but also the most expensive ac-ac system. It has been used in the Finnish icebreakers *Otso*, *Finnica* and *Nordica*, in the Russian *Taymyr*-class icebreakers and in Canadian light icebreakers. By employing cyclo-converters, the motors can be precisely and steplessly controlled by a highly reliable control

setup. Its advantages are the availability of full torque over the entire range of speed, no loss of synchronization, operation of the prime mover at its optimum speed, and the availability of power for auxiliary systems from the main generators. Its main disadvantages are the high capital cost, high volume and weight, and relatively poor overall transmission efficiency of 90–92% (estimated), although the transmission efficiency of ac-FFC-ac systems is higher than that for ac-dc and dc-dc systems.

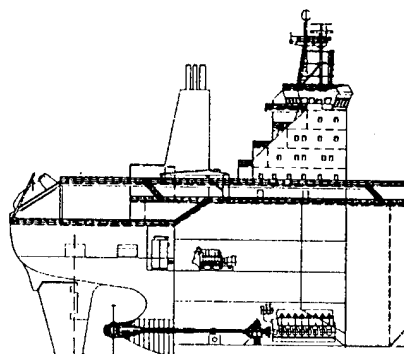
Azimuth propulsion drive

Azimuth propulsion drives have been installed on different types of vessels, such as icebreakers, cargo ships, ferries, cruise ships, etc. One of the *Lunni* series tankers, *Uikku*, was converted in 1993 to accommodate 11.4-MW azimuth propulsion drives (one of the world's most powerful units), replacing the original medium-speed diesel, gearing, shafting and controllable-pitch propellers. Installation of these units on the multipurpose icebreakers *Fennica* and *Nordica* has produced excellent icebreaking and maneuvering capabilities. With their advanced hulls (designed to give excellent seakeeping in open waters [Fig. 9]), these vessels can make continuous progress through 1.8-m-thick ice. Their icebreaking capabilities are also very good when they are moving astern. The azimuth thruster units allow these ships to turn on the spot in ice conditions. Lohi et al. (1994) give the results of full-scale ice tests with *Fennica* during her trials in the Baltic.

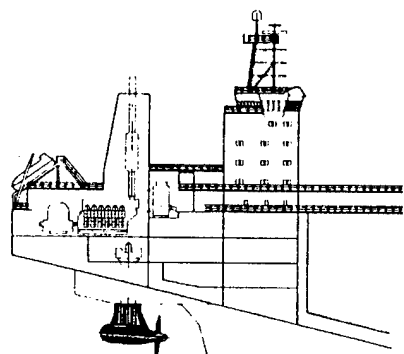
There are two commercial azimuth propulsion systems available—Aquamaster and Azipod. In an Azipod unit, an ac electrical motor is located inside the pod, whereas the motor is located above the azimuth thruster units in Aquamaster drives. The motor, controlled by a frequency converter, directly drives a fixed-pitch propeller, which is either open or placed in a nozzle. These drives azimuthally move 360° and supply full power in all directions.

Figure 17 shows the difference between conventional diesel-mechanical and azimuth propulsion systems on an arctic tanker. The azimuth system has the following advantages:

1. Gives excellent dynamic performance and maneuvering characteristics.
2. Eliminates the need for long shaft lines, transverse stern thrusters, controllable-pitch propellers and reduction gears.
3. Allows new ways for designing machinery and cargo spaces.



Diesel-mechanical Propulsion System



Azimuth Propulsion System

Figure 17. Differences between diesel-mechanical and azimuth installations (after Kværner Masa-Yards and ABB, no date).

4. Reduces noise and vibrations.
5. Provides operational flexibility, resulting in lower fuel consumption, reduced maintenance costs, fewer exhaust emissions and adequate redundancy with less installed power.

In late 1990, the propulsion system of the Finnish waterway service vessel *Seili* was converted from diesel-mechanical propulsion to azimuth (Azipod) propulsion. The performance of this vessel was tested in 65-cm-thick, level ice in the Gulf of Bothnia. Laukia (1993) reported that, besides good maneuverability and icebreaking capability in level ice and first-year pressure ridges, the vessel broke ice better when moving astern than while moving ahead. There are unconfirmed reports that new vessels with two types of hulls at each end are on the drawing boards of shipyards: a smooth bow for moving forward in open-water, and an icebreaking stern for moving astern through first-year ice in sheltered areas.

Prime movers

The characteristics of an ideal prime mover for an icebreaking ship are reliability, flexibility, ma-

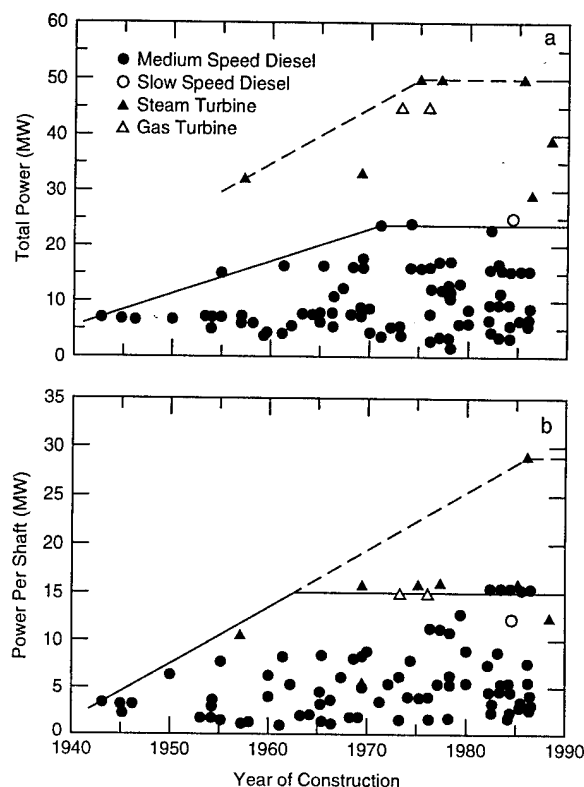


Figure 18. Prime movers installed on icebreaking ships: (a) total power vs. year of construction, and (b) power per shaft vs. year of construction (after Dick and Laframboise 1989).

neuverability, robustness and over-torque capability (Dick and Laframboise 1989). These characteristics have been discussed earlier for the propulsion system. The prime movers used currently in polar ships do not have all these characteristics, but in combination with a suitable transmission, the overall propulsion system can approach the above-mentioned ideal characteristics.

Figure 18 shows two plots of total installed power and power per shaft versus the year of construction. In Figure 18 different types of prime movers have been identified. Each type is briefly discussed in the following.

Gas turbines

Only two icebreakers, the USCG *Polar Star* and *Polar Sea*, are fitted with gas turbines. Each ship has three aero-engine derivative gas turbines, each driving a controllable-pitch propeller through a gearbox. These turbines are used only for heavy icebreaking, and a medium-speed diesel-electric propulsion system is used for cruising and light icebreaking. The Canadian icebreaker *Norman McLeod Rogers* was initially fitted with two indus-

trial turbines, but they were replaced with medium-speed diesel engines because of high fuel consumption.

Turbines are unidirectional engines, and the astern operations must be provided by the transmission, usually through an electrical system, a reversing gear or a controllable-pitch propeller. The advantages of gas turbines over other prime movers are their high power-to-weight ratio and their compactness. Their main disadvantages are the high fuel consumption and maintenance requirements.

Steam turbines

Only the Russian nuclear-fueled icebreakers and icebreaking cargo ships are fitted with modern steam turbines. The Canadian icebreaker *Louis S. St. Laurent* was fitted with a steam-turbine-electric system, but a diesel-electric system was installed during the ship's major reconstruction program, completed in 1993. The efficiency of a steam turbine is about 20%, compared to 50% for modern marine diesel engines (Dick et al. 1987). Similar to gas turbines, steam turbines are unidirectional engines, and astern operations must be handled by the transmission. Turbines can operate at any power level, but the fuel efficiency is poor at reduced power levels.

Medium-speed diesel engines

Medium-speed diesel engines have most commonly been used as prime movers for the propulsion of polar ships because of their compactness, light weight, fuel efficiency and good reliability (Dick and Laframboise 1989). Their disadvantage for use as prime movers is their lack of significant over-torque capacity. However, this shortcoming is overcome by using an electrical transmission, which damps out the high torque transients and stops them from being transmitted to the engine. A few icebreakers are fitted with these engines driving controllable-pitch propellers through gears. Some of the direct drive systems consist of fluid couplings to prevent engine stall under the most severe propeller overloads.

In the past 15 years, medium-speed diesel engines have undergone developments that have allowed them to have better fuel economy, burn heavier grades of fuel, increase routine maintenance intervals and increase the power per cylinder. Some of the largest engines of this type can generate about 22 MW at 400 rpm in 18 cylinders arranged in a vee form (Dick et al. 1987). The engines operate in one direction, and separate pro-

visions, in the form of controllable-pitch propellers or reversing gears, are used for astern operations. Typical specific fuel consumption of the engines is between 170 and 200 g/kWh, and the consumption of lubricating oil is between 1.5 and 3 g/kWh. Most medium-speed diesel engines for icebreakers use turbochargers to improve their fuel efficiency in open water. Diesel engines are basically constant torque machines in the 50–100% range of speed. At a given load, torque may exceed the rated capacity by about 10%. The flexibility of diesel engines is acceptable because they can operate between 25 and 35% of their rated speed, depending upon the characteristics of a particular engine. It is expected that medium-speed diesel engines will continue to be the preferred prime movers for polar ships of all sizes in the near future (Dick et al. 1987).

Slow-speed diesel engines

The Russian LASH ship *Alexey Kosygin* is the only polar ship fitted with two slow-speed diesel engines, each delivering 13.4 MW to directly drive fixed-pitch propellers (Dick et al. 1987). This type of engine was specifically developed for ship propulsion. They operate on the two-stroke cycle, are reversible, and are directly coupled to propellers, mostly of the fixed-pitch type. The range of their rotational speed is between 60 and 225 rpm. The range of cylinder bore diameter is from 250 to 900 mm. The maximum power per cylinder is about 3.7 MW. This type of engine is large and heavy, and it can only be fitted to vessels that can provide a large engine room and carry the extra weight: bulk cargo ships, oil tankers and container ships. Ferries, Ro/Ro ships and barge carriers have limited head room and are generally fitted with medium-speed diesel engines. These engines are not suitable for polar ships because of their poor maneuverability and flexibility.

Developments in the last 15 years include the use of constant pressure turbocharger technology and the adoption of extra-long strokes. This has enabled slower propeller speeds without the use of gears, resulting in higher propulsion efficiency in large bulk carriers and oil tankers. The specific fuel consumption of these engines is below 160 g/kWh for large economical engines, and about 175 g/kWh for small engines.

Combined prime movers

The reason for combining two different prime movers in a ship is to improve the overall fuel economy. This is done by either recovering the

waste heat and converting it to mechanical work, or by operating each prime mover according to load demands to obtain better fuel economy. The first option has not been used in icebreakers so far.

The USCG icebreakers *Polar Sea* and *Polar Star* are the only polar vessels fitted with two types of prime movers. In these ships, there are three gas turbines (total 45 MW or 60,000 shp) and three diesel-electric propulsion systems (total 13.4 MW or 18,000 shp) for each of the three controllable-pitch propellers. Each shaft can be turned either by the diesel-electric or the gas turbine power plant. Either one or two 2.24-MW (3000-shp) diesel-electric drive units, or a single 15-MW (20,000-shp) gas turbine, can be used to drive each shaft. For example, diesel engines could supply power to the wing shafts, while a gas turbine could turn the center shaft. Gas turbines are used for heavy icebreaking, whereas the diesels are used for cruising and light icebreaking. This is a good example of combining two different systems to meet widely differing load demands for the sake of fuel economy.

AUXILIARY SYSTEMS

There have been other developments to improve the performance of polar ships besides those in propulsion systems and hull shapes, such as the use of low-friction coatings on the hull, air-bubblers to lubricate the ice/ship interface, air-bubbler-water-injection systems, and the water-deluge (or wash) system to pump a large volume of water on the ice ahead of the vessel. These improvements have also contributed to increase the icebreaking capability of polar ships beyond the limit for which they were designed. A brief account of each auxiliary system follows.

Low-friction hull coating

Depending on the age of a vessel, the coefficient of friction between ice and unpainted hull plating can be in the range of 0.2 to 0.3, which is high in comparison to the friction coefficient in the range of 0.05 to 0.17 between ice and a low-friction coating. As discussed later, the factor to account for the friction of old steel in the expression for ice resistance of an icebreaker is twice that for Inerta-coated steel plates (Keinonen et al. 1991).

Prior to the 1970s, there was no suitable coating available that could withstand interaction with ice. Only anti-fouling paint was applied to the hulls to minimize biological growth on the hull surface,

and this would wear off during first few days of icebreaking. In the early 1970s, the importance of hull-ice friction on the ice resistance was demonstrated through full-scale and laboratory tests. A measure of the force attributable to static friction acting on a hull can be obtained by gradually increasing the level of power to initiate forward motion of a ship that was stopped in ice and then measuring the steady-state velocity at that same power level. For ships having uncoated hulls, this power level corresponds to a 3-knot (1.5-m/s) speed of advance, whereas for a ship with low-friction coating, the initiating power levels are equivalent to a speed of 0.5 knots (0.26 m/s) (Voelker 1990). The power required for an icebreaker with a low-friction coating to become unstuck is much lower than that for ships without any coating.

Mäkinen et al. (1994) have given an historical account of the development of low-friction coatings in Finland, where the first effective hull coatings were developed by Wärtsilä Shipyard (now Kværner Masa-Yards). Liukkonen (1992) developed a theoretical understanding of hull-ice friction and found a functional relationship between the coefficient of friction and the normal force. This functional relationship was verified by full-scale measurements of normal and frictional forces with the help of instrumented panels installed in the bow and the sides of icebreakers.

Mäkinen et al. (1994) have listed the requirements of a good low-friction coating. A few of these are reasonable cost, high bond strength with and good corrosion protection for the base material, and resistance to all of the following: wear, high normal pressure, low temperatures and changes in temperature. Tests were conducted on many different coatings; Inerta 160 and stainless steel were selected for full-scale testing and further development. Another coating by the name of Zebron was also found to be suitable, but its use has decreased with time, perhaps because of lower resistance to wear.

Inerta 160 has been applied to hundreds of ships currently in service (Mäkinen et al. 1994). It is applied with a two-component spray gun, which has heating equipment to keep the temperature of the paint between 40 to 50°C. Two problems associated with the application of Inerta 160 were corrosion of cast iron propellers and corrosion of hull surfaces. These problems were corrected by using stainless steel propellers and cathodic corrosion protection.

An important property of a coating is to withstand the deformation of the base material. In the

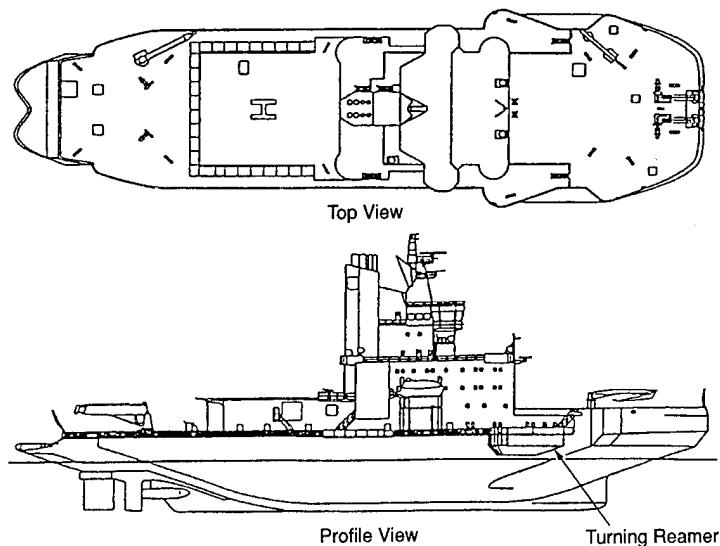


Figure 19. Outboard profile and topside deck plan of the Swedish icebreaker *Oden*.

case of Inerta 160, the wear-off starts at the cracks caused by the deformation of the shell plating at the edges of the ship's frames. The wear-off is intensified in heavily loaded areas, such as the ice belt in the ship's forebody, and during operations in heavy ice and especially in the presence of soil or sand mixed in ice. To correct this deficiency in Inerta 160, stainless-steel-coated surfaces, though expensive, were developed because of their high wear resistance and low-friction properties. Cathodic protection systems were developed to reduce the corrosion risks before compound steels with stainless steel claddings were installed in the ice belt regions on two *Otso*-class icebreakers for testing. Later, stainless steel compound plates were installed on the Russian icebreaker *Kapitan Nikolayev* and the Finnish icebreakers *Finnica* and *Nordica* with very favorable results.

The cost of applying Inerta 160 and installing stainless steel compound plates is, respectively, about 2 and 40 times the cost of applying conventional paint (Mäkinen et al. 1994). However, the extra cost of applying Inerta 160 may be offset by longer periods (4–5 years vs. 1 year) between reapplications of the coating, while compound steel does not require any repair or reapplication. There have been no corrosion problems with compound plate; however, the cathodic protection systems must be permanently activated, even during the summer. Investigations are currently underway to use copper-nickel compound plates as an alternative to stainless steel compound plates (Mäkinen et al. 1994).

Heeling system

In earlier times, the crews of cargo ships that were stuck in ice found that lifting a heavy weight by a crane and swinging it sideways helped to free the ship. This experience led the designers of icebreakers to install heeling tanks on each side of a ship and to provide for pumping large amounts of water back and forth between the tanks. The continuous rolling motion of a ship facilitates its progress in ice with less power.

Now most operators consider the heeling system important for improved icebreaking and maneuvering. Almost all Baltic icebreakers have heeling tanks. The Swedish icebreaker *Oden* was fitted with a fast heeling system that allows full heeling in 15 seconds (Backman 1994). This has enabled *Oden* to make continuous

progress in heavy ridges. *Oden* is also fitted with turning reamers located above the ice surface on each side just aft of the bow (Fig. 19), and when the ship is heeled over, one reamer comes in contact with ice to help the ship to turn sharply into the heel (Johansson et al. 1994). Thus, a heeling system in combination with the turning reamers has improved the maneuverability of *Oden* by decreasing the turning radius. With improved maneuverability, polar ships are often able to make progress in thicker ice than they have been designed for, by finding a path of least resistance through the weaknesses in an ice cover. This is demonstrated by the successful voyage of *Oden* in 1991 with the German icebreaker *Polarstern* to the North Pole.

Air-bubbler system

An air-bubbler system releases large volumes of air through nozzles into the water below the ice in the bow and midbody portions of a ship. When the air rises to the surface, it brings water with it between the ice and the hull, thus reducing friction between them.

This system was first introduced on the Finnish icebreaking ferry *Finncarrier* in 1969 (Johansson et al. 1994). It has since been installed on vessels with conventional bows, such as the *Lunni* class of icebreaking tankers, the Canadian icebreaking cargo ship *Arctic*, and the Russian SA15's. The results of full-scale trials indicate that a bubbler system may help in reducing friction only in the low-speed range (less than 2 m/s or 4 knots). There

is no measurable benefit of an air-bubbler system on ships with unconventional bows. Captains of Bay-class Great Lakes icebreakers report that air bubblers are very useful for docking or leaving the docks under ice conditions.

To assess the effectiveness of hull lubrication by an air-bubbler system, the ratio of shaft power saved at a given speed in level ice to the power required to operate the system is computed. If this ratio is more than one, there is a net power saving in operating the system. According to the data compiled by Keinonen et al. (1991), this ratio for the air-bubbler system of hull lubrication is generally less than, or in some cases barely greater than, one. The reason for such low efficiency is that lubrication is not provided around the bow waterline, where it would be most effective.

Air-bubbler-water injection system

This system, installed on the German icebreaker *Polarstern*, injects air into the water being pumped to nozzles at the sides of the ship below the ice. Air-water jets have also been installed below the water on the Canadian icebreaker *Ikaluk* and the newly converted Russian icebreaker *Mudyug*. The ratio of power saved to the power expended is about one (Keinonen et al. 1991).

Water-deluge system

Recent developments, such as the water-deluge system and low-friction epoxy paint, have allowed the use of unconventional bows on sea-going vessels (Johansson et al. 1994). A water-deluge system throws several tons of water every second on top of the ice ahead of the bow. This not only reduces friction between the ice and the hull but also submerges the broken ice pieces to help them move down under the hull. This was first installed on the Canadian icebreaker *Canmar Kigoriak*, which was fitted with a blunt spoon-shaped bow, to solve the ice pushing problem experienced with unconventional bows in the late nineteenth century. One time, when the water-deluge system was frozen solid, the *Kigoriak* could not make good progress through a broken ice cover because of the ice-pushing problem. With the water-deluge system operating perfectly a few days later, she was able to make good progress in this same broken ice field (Johansson et al. 1994).

According to the data compiled by Keinonen et al. (1991), the power saved as a result of operating a water-deluge system is much greater than the power expended. These data were collected for the

Canmar Kigoriak during icebreaking with a bare hull and also with an epoxy-coated hull.

On the Canadian icebreaking supply vessel *Robert Lemeur*, this system has been effective in reducing the resistance by 20–30% over the entire speed range (Dick and Laframboise 1989). On the Swedish icebreaker *Oden*, the water-deluge system has been upgraded to act as a bow thruster by directing the flow to one side of the ship. With a control system and a modified nozzle design, it is possible to obtain a side force of 0.1 MN at the forward tip of the ship.

POWER AND PERFORMANCE

As expected, installed power increases with ship size as represented by ship beam. The power-versus-beam plot of the data on existing polar ships (Fig. 20) shows a trend of increasing power as a function of beam. Except for a few data points, there appears to be a well-defined relationship between power and beam.

Using information on the performance of existing polar ships in ice, Dick and Laframboise (1989) plotted the bollard pull/beam vs. the ice thickness an icebreaker is capable of breaking at a speed of about 1 m/s or 2 knots (Fig. 21). For comparison, the data are normalized on performance for a speed of 2 knots. There appears to be a well-defined minimum performance. For a particular bollard pull/beam, the range of ice thickness above a minimum performance value represents an improvement in icebreaking capability of the hull shape. Figure 21 shows that the most recent ships have more efficient hull forms.

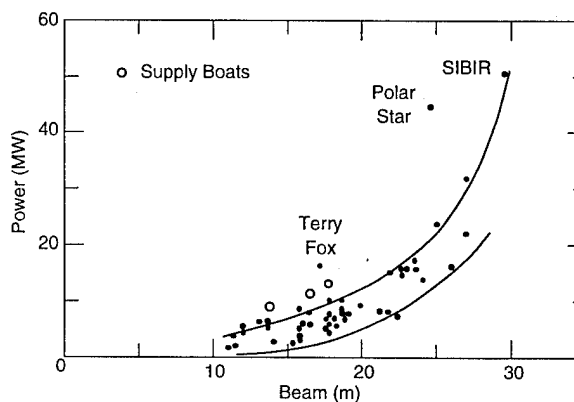


Figure 20. Power vs. beam for icebreakers (after Dick and Laframboise 1989).

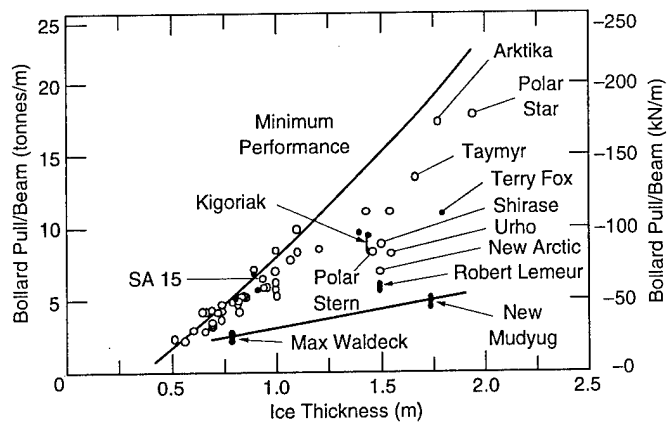


Figure 21. Icebreaking performance: bollard pull/beam vs. ice thickness. Bollard pull is measured or calculated; data are adjusted for a speed of 2 knots (after Dick and Laframboise 1989).

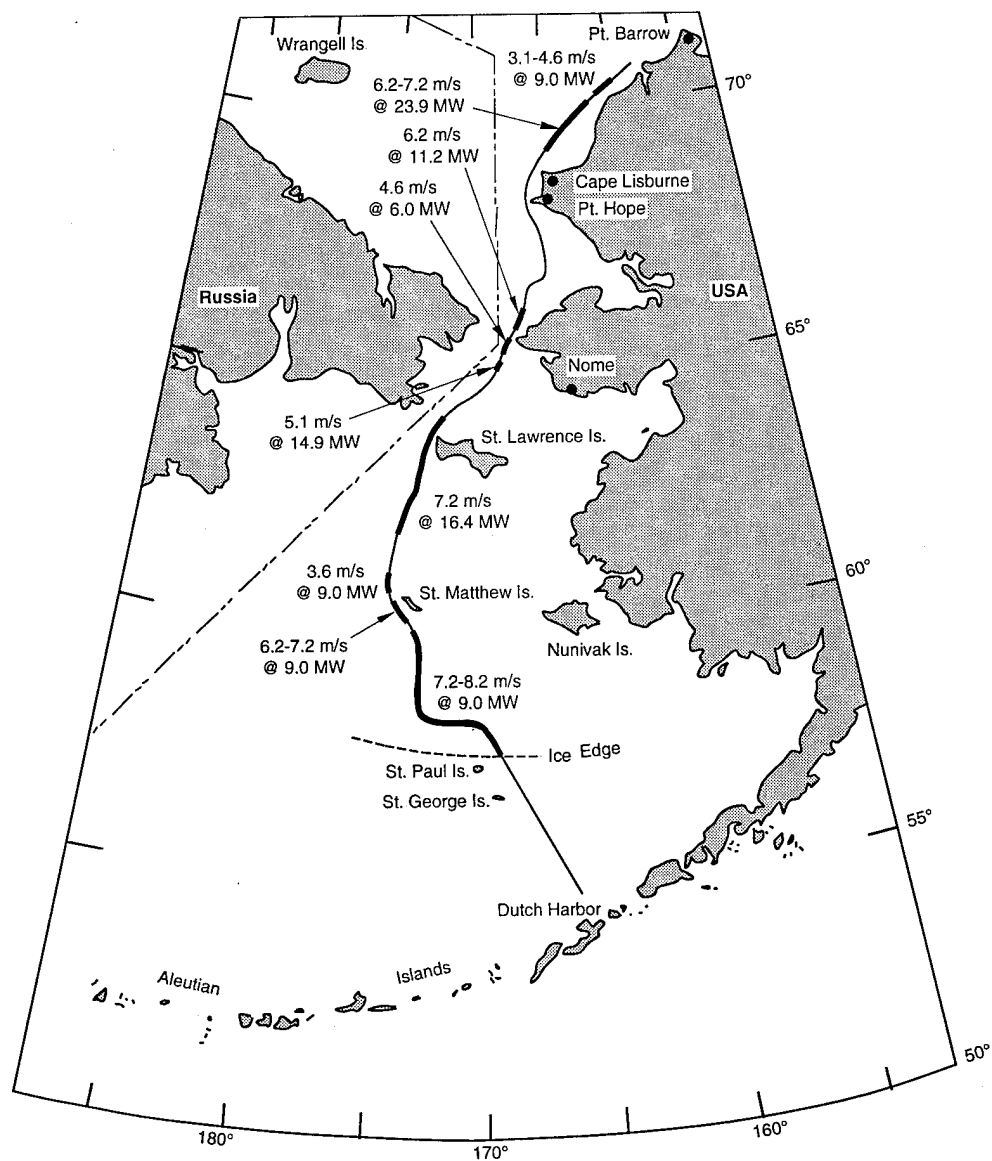


Figure 22. Speeds and power levels of U.S. icebreaker Polar Sea during her transit from 23 March to 4 April 1983 (after Voelker 1991).

Table 2. Estimates of daily fuel consumption for a *Polar*-class ice-breaker.

Ship status	Fuel consumption rate	
	(gallons/day)	(tons/day)*
Stationary—systems providing only normal hotel services	4,000	12
Open water transit (three propulsion diesel)	14,000	42
Icebreaking (six propulsion diesel)	25,000	75
Icebreaking (diesel on wing shafts, gas turbine on center shaft)	35,000	105
Icebreaking (three gas turbines)	60,000	180

* Relation used for conversion: 1000 gallons/day \approx 3 tons/day.

Fuel consumption rates

The fuel consumption rates of medium-speed and slow-speed diesel engines have been mentioned earlier. These rates may have been obtained for open water conditions. Data on the actual fuel consumption of icebreakers working in ice are very scarce.

Voelker (1990) has summarized the mean fuel consumption rates of 16 *Polar*-class ship deployments to the Alaskan Arctic (Table 2). The rate of fuel consumed depends on the ship's activity and the power plant being used. The *Polar Sea* and *Polar Star* can each generate up to 13.4 MW (18,000 shp) using diesel-electric propulsion systems. Alternatively, they can generate up to 45 MW (60,000 shp) by engaging their gas-turbine power plants. In Figure 22, Voelker's route map shows the sustained speeds for various power outputs during a midwinter expedition through the Bering Sea and

into the Alaskan Chukchi Sea. Figure 23 identifies sections of the route where ramming of the ice was required to make headway. The number of rams and the average shaft power used are also given in Figure 23.

According to the brochures of the Murmansk Shipping Company, the rates of fuel consumption of three classes of ships (*Noril'sk*, *Mikhail Strekalovskiy* and *Dimitriy Donskoy*) are listed in Table 3.

Performance prediction

Keinonen et al. (1991) compared the performance of 18 major icebreakers of different sizes and types to establish methods of expressing and estimating their performance in terms of ship design features and parameters. The data were obtained from full-scale trials of icebreakers in different geographical areas as well as in different ice

Table 3. Fuel consumption rates of a few Russian ships according to the information given in the brochures of the Murmansk Shipping Company.

Ship	Type of fuel or oil	Storage capacity (tons)	Daily consumption rate (tons/day)		
			Underway	In port	
				Cargo operation	No cargo operation
SA15's <i>Noril'sk</i> Class	Diesel oil	783	2.0	2.0	1.0
	High viscosity fuel	3743	76.0	7.0	3.0
	Lubricating oil	185	0.6	0.1	0.1
<i>Mikhail Strekalovskiy</i> Class	Diesel oil	329	5.0	2.5	2.5
	High viscosity fuel	1348	43.1	7.3	7.3
	Lubricating oil	52	0.3	—	—
<i>Dimitriy Donskoy</i> Class	Diesel oil	329	5.0	2.5	2.5
	High viscosity fuel	1348	43.1	7.3	7.3
	Lubricating oil	52	0.3	—	—

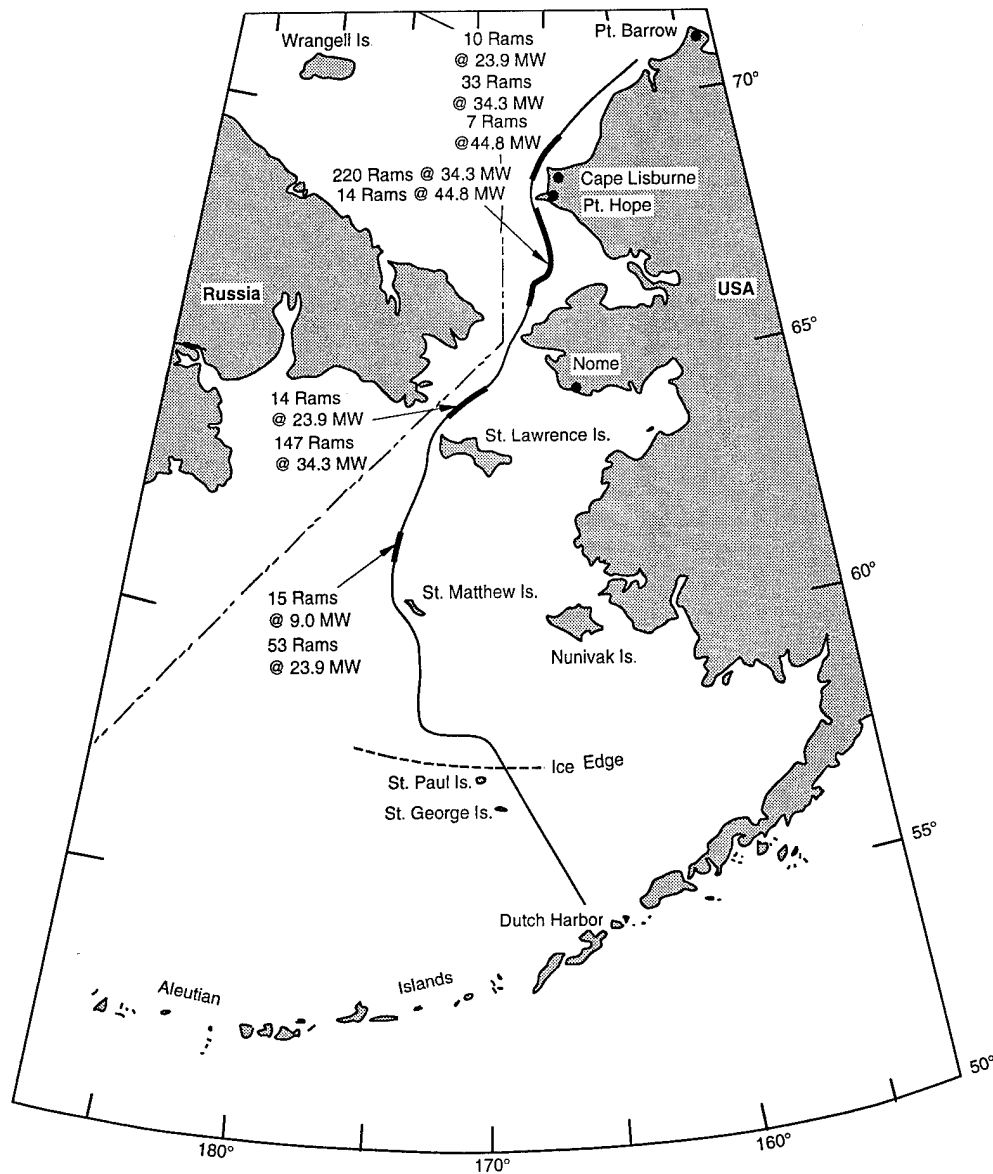


Figure 23. Number of ramming operations during the transit of U.S. icebreaker Polar Sea from 23 March to 4 April 1983 (after Voelker 1991).

conditions. Though most of the hulls were coated with Inerta, a few hulls were bare steel, and one hull was fitted with a stainless-steel band at the waterline. Performance measures included in their study are level-ice hull resistance, propulsive performance, hull lubrication, ridge resistance, turning performance and open water resistance. According to Keinonen et al. (1991), these results were compiled to understand the influence of key parameters on the performance of icebreakers. The key parameters chosen for this comparison were simple and obvious to all observers. For detailed

information, readers are referred to their paper and to the reports prepared for that study. A summary of their performance predictors is given below.

Resistance in level ice

For chined ships, an expression for ice resistance at a speed of 1 m/s is given as

$$R_I = 0.08 + 0.0177 C_S C_H B^{0.7} L^{0.2} T^{0.1} H^{1.25} \\ \{1 - 0.0083 (t + 30)\} \{0.63 + 0.00074 \sigma_f\} \\ \{1 + 0.0018 (90 - \psi)^{1.4}\} \{1 + 0.004 (\phi - 5)^{1.5}\}$$

where R_1 = resistance in level ice at 1 m/s (MN)
 C_S = water salinity coefficient (saline = 1, brackish = 0.85 and fresh = 0.75)
 C_H = hull condition factor (Inerta = 1, new bare steel = 1.33 and old bare steel = 2)
 B = ship beam (m)
 L = waterline length of ship (m)
 T = draft of ship (m)
 H = ice thickness, taken to be ice thickness plus half the snow depth (m)
 t = ice surface or air temperature ($^{\circ}\text{C}$)
 σ_f = flexural strength of ice (kPa)
 ψ = average flare angle in bow region ($^{\circ}$)
 ϕ = average buttock angle in bow region ($^{\circ}$).

For rounded-shoulder ships, an expression (using the same symbols) for the ice resistance at a speed of 1 m/s is given as

$$R_1 = 0.015 C_S C_H B^{0.7} L^{0.2} T^{0.1} H^{1.5} \\ (1 - 0.0083 (t + 30)) \{0.63 + 0.00074 \sigma_f\} \\ (1 + 0.0018 (90 - \psi)^{1.6}) \{1 + 0.003 (\phi - 5)^{1.5}\}.$$

Energy to penetrate an unconsolidated ridge

Based on the full-scale data, an expression for the energy to penetrate an unconsolidated ridge is given as

$$E_R = 0.25 A_C A_R C_S C_H \{1 - 0.0083 (t + 30)\} \\ (1 + 0.012 (90 - \psi))$$

where E_R = energy for ridge penetration (MJ)
 A_C = largest cross-sectional area of vessel (m^2)
 A_R = ridge depth \times ridge profile length (rubble only) (m^2)
 C_S = water salinity coefficient (saline = 1, brackish = 0.85 and fresh = 0.75)
 C_H = hull condition factor (Inerta = 1, new bare steel = 1.33 and old bare steel = 2)
 t = ice surface or air temperature ($^{\circ}\text{C}$)
 ψ = average flare angle in bow region ($^{\circ}$).

Turning circle diameter

For vertical-sided chined vessels, and in level ice of thickness equal to 60% of the icebreaking capability at 1 m/s

$$D/L_{WL} = 38 \times 0.56^x$$

where D = turning diameter (m)
 L_{WL} = length of waterline of ship (m)
 x = reamer width relative to midbody length (%).

For rounded vessels with fully effective rudders, and in level ice of thickness equal to 60% of the icebreaking capability at 1 m/s

$$D/L_{WL} = 0.022 (PMB)^{1.75} + 3$$

where PMB is the percentage of waterline length representing a parallel midbody (%).

For rounded vessels with partially effective rudders, and in level ice of thickness equal to 60% of the icebreaking capability at 1 m/s

$$D/L_{WL} = 0.14 (PMB)^{1.5} + 3.$$

Open water resistance

For chined vessels, open water resistance is expressed in terms of Froude number

$$R/Disp = 1.1 F_n^{1.64}$$

where R = open water resistance (kN)

$Disp$ = ship displacement (tons)

F_n = Froude number $\left(v / \sqrt{gL} \right)$

v = ship velocity

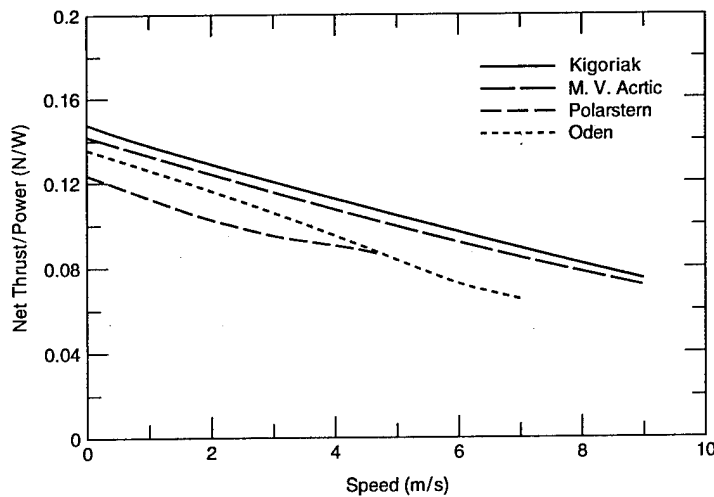
L = ship length between perpendiculars.

For vessels of rounded shapes, open water resistance is expressed in terms of Froude number

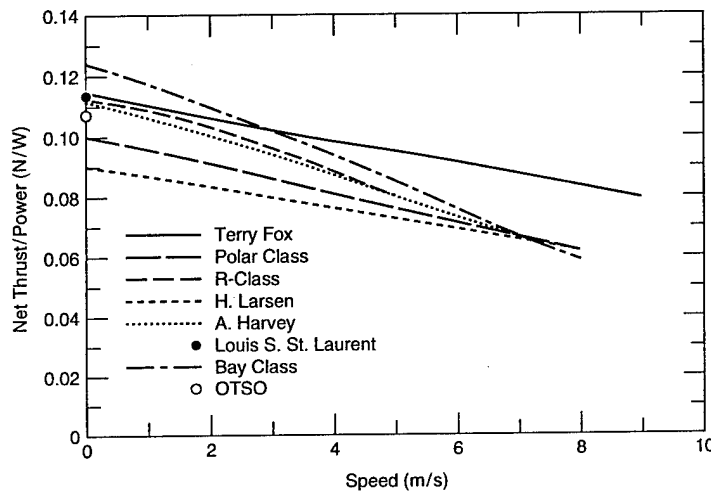
$$R/Disp = 0.4 F_n^{1.68}.$$

Propulsive performance

Propulsive performance is defined as the ratio of net thrust to the shaft power (or specific net thrust). Keinonen et al. (1991) compared the propulsive performance of different icebreakers at full power. The data are shown in Figure 24a for different speeds for ships having ducted propellers, whereas similar data for ships with open propellers are shown in Figure 24b. A comparison of the data for the single-screw, ducted, controllable-pitch system of *Kigoriak* and *Arctic* with that of twin-screw, open, controllable-pitch system of *Terry Fox* shows that the net propulsive performance of the ducted systems has an advantage of 27% over the open system at low speeds. However, this advantage decreases at higher speed until both systems have the same specific net thrusts.



a. Propellers in nozzles.



b. Open propellers.

Figure 24. Specific net thrust vs. speed at maximum shaft power, indicating propulsive performance (after Keinonen et al. 1991).

FUTURE ICEBREAKERS

At present, some of the largest icebreakers, such as the Russian *Yamal*, are capable of operating in multi-year ice without any concern for possible damage, often at speeds in the range of 15–20 knots (7.7–10.3 m/s) (Brigham 1994). The icebreakers of this class are strongly built, with a robust propulsion system. Because of nuclear power, their unlimited endurance sets this class of ships apart from the rest of the icebreakers in the world. Detailed information about the icebreaker *Yamal* by R.K. Headlands of Scott Polar Institute is given in Appendix A, which states that the maximum ice thickness *Yamal* can penetrate while navigating is estimated to be 5 m, and that *Yamal* has broken through individual ridges estimated to be 9 m thick.

The contract to build an icebreaker, named *Healy*, for the U.S. Coast Guard has been executed, with

a delivery scheduled for mid-1998.* Its displacement will be 16,303 tons, and its length, beam and maximum draft will, respectively, be 128 m, 25 m and 9.75 m. The propulsion systems will consist of 22.4 MW (30,000 hp), medium-speed diesel engines with ac-ac electrical transmission to drive two fixed-pitch propellers. Model tests indicate that it will be able to break 1.6-m-thick, level ice continuously. It will have a dynamic positioning system to support oceanographic research.

The design and model testing of a new U.S. Arctic Research Vessel has been completed (Kristensen et al. 1994), but it is not known at this time when this research vessel will be built. This vessel will support science missions in the Arctic well into

* Personal communication, A.D. Summy, Captain, U.S. Coast Guard, 1994.

the next century. The ship will have an overall length of 103.6 m, waterline length of 93.9 m, maximum beam of 27.1 m, depth of 12.2 m, draft of 9.1 m and a displacement of 11,684 tons. The vessel will have a flat bow with a ridge in the middle to break ice in bending and to clear it on the side, and a double hull to comply with the CASPPR guidelines. The propulsion system will include diesel engines of 15 MW (20,000 hp) and two-ducted 4.1-m-diameter controllable-pitch propellers.

As mentioned earlier, it is well within known and proven technology and experience to design, build and operate an icebreaker year-round independently in the Arctic. Keinonen (1994) has set down the performance criteria of a proposed icebreaker for the Northwest Passage, as given in Table 4. The design parameters of the icebreaker are given in Table 5, in which the values of those parameters for *Yamal* are also given for comparison. It can be seen that the icebreaker proposed

for the Northwest Passage is slightly bigger in size and displacement than *Yamal*, but the designed installed power (from diesel engines with a mechanical transmission to two controllable-pitch propellers in nozzles) is less than that of *Yamal*, which is equipped with three propellers driven by nuclear power through an electrical transmission. Auxiliary systems for the Northwest Passage icebreaker include water wash and heeling tanks, as well as a stainless steel belt with Inerta coating elsewhere.

Figure 25 is a sketch of an "iceraker," as proposed by Johansson et al. (1994). The proposed iceraker has a vertical-sided, 50-m-wide hull that also has a submerged cantilever in front of and on each side of the vertical, wedge-shaped bow. At the edge of this cantilever, air is introduced into the water at a depth of about 15 m. Seven spurs are located on top of the cantilever at a transverse spacing of about 20 m. The spurs create a 120-m-wide channel of broken ice by deflecting a floating

Table 4. Performance criteria for a Northwest Passage icebreaker (after Keinonen 1994).

Performance	Criteria/measure	Requirements
Level ice	2 knots at continuous speed	3 m
Multi-year ice	Thickest broken ice on first ram	8 m
Backing	Thickest level ice broken in a continuous motion	2 m
Turning	Thickest ice below which turning circle is smaller than $10 \times L_{wl}$	2 m
Extraction	Wind speed in which able to extract (also needs to be able to extract after any ram)	15.4 m/s (30 knots)

Table 5. Comparison of design parameters of proposed Northwest Passage icebreaker (Keinonen 1994) with those of the Russian icebreaker *Yamal*.

Parameter	Unit	Proposed values for a Northwest Passage icebreaker	Values for the Russian icebreaker <i>Yamal</i>
Displacement	ton	30,000	23,460
Water line length	m	140	136
Length of parallel mid body	m	70	no data
Beam at water line	m	30	28
Draft	m	14	11
Hull design concept	type	four-section bow	conventional, straight wedge shaped, double
Stem/buttock angle	degrees	17	17
Flare/frame opening angle	degrees	60	—
Shaft power	MW	40	56
Propellers	number/type	2CP in nozzles	3FP
Drive system	engine/transmission	diesel/mechanical	nuclear/steam turbine/electrical
Reamers	type—width m	two way—2 m	none
Appendages	names	stern pods, shilling rudders, bottom wedge	ice horn
Auxiliary systems	types	water wash, heeling	air bubbler
Hull coating	types	Stainless and Inerta coating with cathodic protection	polymer coating

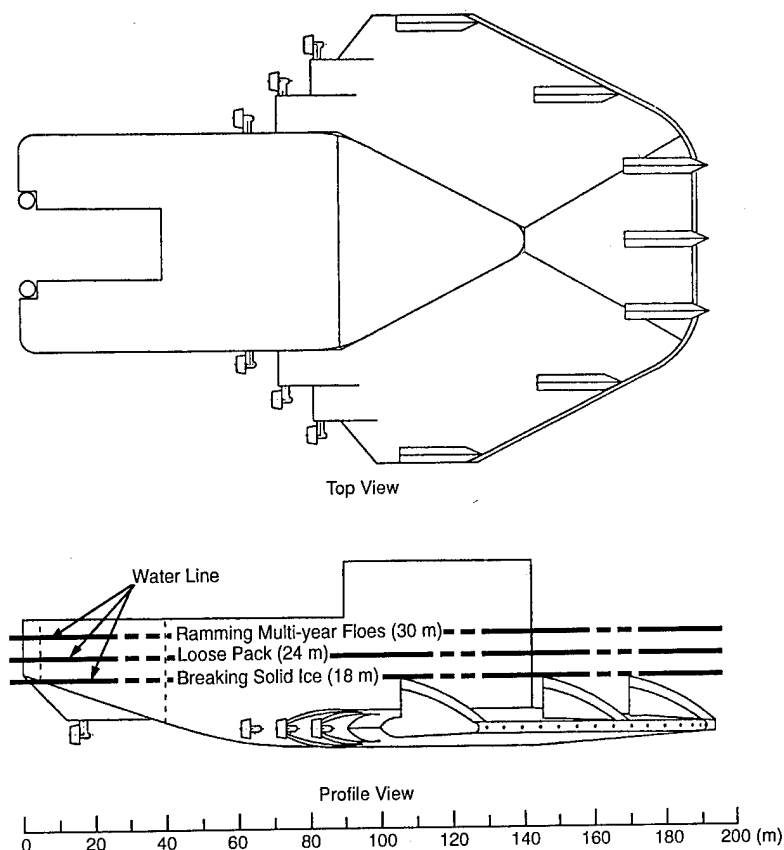


Figure 25. New "iceraking" concept, as proposed by Johansson et al. (1994).

ice sheet upward sufficiently to fracture it. The air released from the edge of the cantilever produces a current to take the broken ice pieces past the 60-m-wide main body of the iceraker. While moving through broken ice, the iceraker is submerged to a deeper level so that the spurs do not contact the ice. To break a thick (8-m) multiyear ice floe, the iceraker is submerged even deeper and allowed to strike the floe to split it in a single impact.

The proposed "iceraker" represents an innovation that may not become a reality for a long time. Enormous economic driving forces must be present to encourage building this type of vessel that is such a great departure from existing ice-breaking ships.

SUMMARY

The current status of icebreaking technology has been presented, along with a brief history. The improvements in bow designs to break level ice efficiently were suggested more than a hundred years ago. However, those designs could not be implemented in sea-going ships because of ice-pushing problems. With the help of new developments to reduce friction between the ice and the

hull of a ship, it has now become possible to build icebreakers with improved bow shapes to cope with any type of ice. The developments in marine propulsion systems were also incorporated into the icebreaking technology to obtain higher efficiency, reliability, flexibility and maneuverability. Development of auxiliary systems, such as heeling tanks, air-bubbler systems, water-deluge systems, low-friction coatings, etc., allows an icebreaker to perform effectively in ice conditions more severe than those for which they were designed.

A description of the Russian nuclear-powered icebreaker *Yamal* is given in Appendix A. An inventory of ships that are capable of navigating in at least 0.3-m-thick ice is presented in Appendix B.

LITERATURE CITED

- Backman, A.** (1994) Five years operational experience with the Swedish icebreaker *Oden*. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. R1-18.
- Brigham, L.W.** (1987) Emerging polar ship technology—an introduction. *Marine Technology Society Journal*, 21(3): 3-5.

- Brigham, L.W.** (1991) Technical developments and the future of Soviet Arctic marine transportation. In *The Soviet Maritime Arctic* (L. W. Brigham, Ed.). Annapolis, Maryland: Naval Institute Press.
- Brigham, L.W.** (1992) Modern icebreaking ships. In *The Shipping Revolution: The Modern Merchant Ship* (R. Gardiner, Ed.). London: Conway Maritime Press, p. 154–158.
- Brigham, L.W.** (1994) Observations of the Russian icebreaker *Yamal*. Memorandum dated 2 September (unpublished).
- Dick, R.A. and J.E. Laframboise** (1989) An empirical review of the design and performance of icebreakers. *Marine Technology*, 26(2): 145–159.
- Dick, R.A., D.N. Baker, E.W. Thompson and H.C. Cheung** (1987) *Arctic Ship Technology*. Transport Canada Report TP 8094E. Ottawa, Ontario: Melville Shipping Ltd.
- DesRochers, C.G., E.J. Crocker and I. Bayly** (1994) Post yield buckling of stiffened panel structures. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. K1–11.
- Frederking, R.** (1977) Plane-strain compressive strength of columnar-grained and granular-snow ice. *Journal of Glaciology*, 18(81): 505–516.
- Ierusalimsky, A.V. and L.G. Tsoy** (1994) The efficiency of using non-traditional hull lines for icebreakers. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. S1–10.
- Johansson, B.M., J. Ciring, W. Jolles, E. Stalder and R.D. Rowe** (1994) Revolutionary icebreaker design. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. O1–34.
- Karavanov, S.B. and Y.V. Glebko** (1994) New Russian Arctic regulations versus CASPPR. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. C1–10.
- Keinonen, A.** (1994) Icebreaker for North West Passage, a designer's perspective. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. W1–10.
- Keinonen, A., R.P. Browne, C.R. Revill and I.M. Bayly** (1991) Icebreaker performance prediction. *Transactions, The Society of Naval Architects and Marine Engineers*, 99: 221–240.
- Kristensen, D.H., B.L. Hutchison, A. Keinonen, and K.-H. Rupp** (1994) Ice-breaking and open water performance prediction of the new UNOLS/NSF Arctic Research Vessel. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. N1–18.
- Kværner Masa-Yards and ABB** (no date) Azimuthing electric propulsion drive: Azipod. Helsinki, Finland.
- Laukia, K.** (1993) Service proves electric propulsion design. *The Motorship*, February.
- Liukkonen, S.** (1992) Theoretical approach to physically modelling of kinetic friction between ice and ship. In *Proceedings, 11th International Conference on Offshore Mechanics and Arctic Engineering, Calgary, Alberta, Canada*, vol. IV. New York: American Society of Mechanical Engineers, p. 213–222.
- Lohi, P., H. Soininen and A. Keinonen** (1994) MSV *Fennica*, a novel icebreaker concept. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. M1–14.
- Mäkinen, E., S. Liukkonen, A. Nortala-Hoikanen, and A. Harjula** (1994) Friction and hull coatings in ice operations. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. E1–22.
- Masterson, D.M. and R.M.W. Frederking** (1993) Local contact pressures in ship/ice and structure/ice interactions. *Cold Regions Science and Technology*, 21: 169–185.
- Milano, V.R.** (1987) The Thyssen/Waas ice-breaking hull form. *Marine Technology Society Journal*, 21(3): 75–87.
- Mulherin, N.** (1994) Northern Sea Route reconnaissance report: History and present status of operations. USA Cold Regions Research and Engineering Laboratory, Report to the U.S. Army Engineer District, Alaska.
- Mulherin, N., D.S. Sodhi and E. Smallidge** (1994) Northern Sea Route and icebreaking technology: An overview of current conditions. USA Cold Regions Research and Engineering Laboratory, Miscellaneous Paper 3520.
- Ratzlaff, K.P. and D.J.L. Kennedy** (1986) Behaviour and ultimate strength of continuous steel plates subjected to uniform transverse loads. *Canadian Journal of Civil Engineering*, 13: 76–85.
- Richter-Menge, J.A., G.F.N. Cox, N. Perron, G. Durell and H.W. Bosworth** (1986) Triaxial testing of first-year sea ice. USA Cold Regions Research and Engineering Laboratory, CRREL Report 86-16.
- Smith, T.R. and E.M. Schulson** (1994) Brittle compressive failure of salt-water columnar ice under biaxial loading. *Journal of Glaciology*, 40(135): 265–276.
- Santos-Pedro, V.M.** (1994) The case for harmonization of (polar) ships rules. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada*, p. N1–18.

ternational Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada, p. D1-8.

Toomey, P.R.M. (1994) A master's perspective on the performance of icebreakers. In *Proceedings, 5th International Conference on Ships and Marine Structures in Cold Regions, March, Calgary, Alberta, Canada, p. V1-16.*

Voelker, R.P. (1990) Arctic marine transportation program, 1979 to 1986, executive summary. Report No. MA-RD-840-90004 prepared by NKF Engineering, Inc., Arctic Technology Group, Columbia, Maryland, for Maritime Administration, Office of Technology Assessment, Department of Transportation.

APPENDIX A: INFORMATION ABOUT THE NUCLEAR ICEBREAKER YAMAL

(Reproduced from an unpublished description given by R.K. Headland of
Scott Polar Institute, Cambridge University, UK)

The ship is one of three *Rossiia* class icebreakers leased to the Murmansk Shipping Company by the Russian Government (her sisters are *Rossiia* [launched in 1985] and *Sovetskiy Soyuz* [1990]).

The name is derived from a Nenets word meaning "End of the Earth," also applied to the Yamal Peninsula.

Her keel was laid on 25-V-1986 in St. Petersburg and she was launched on 28-X-1992

Registered number M 43048 and International Call Sign UPIL.

Length overall 150 m, at waterline 136 m. Breadth overall 30 m, at waterline 28 m. Draft 11.08 m.

Height, keel to mast head: 55 m on 12 decks (4 below water).

Ice knife, a 2-m-thick steel casting, is situated about 22 m aft of the prow

Displacement 23,455 tonnes; capacity 20,646 gross registered tons.

The cast steel prow is 50 cm thick at its strongest point.

The hull is double with water ballast between them. The outer hull is 48 mm thick armor steel where ice is met and 25 mm elsewhere.

Eight bulkheads allow the ship to be divided into nine watertight compartments.

Ice breaking is assisted by an air bubbling system (delivering 24 m³/s from jets 9 m below the surface), polymer coatings, specialized hull design and capability of rapid movement of ballast water. Ice may be broken while moving ahead or astern.

An M1-2 or KA-32 helicopter is carried for observing ice conditions ahead of the ship.

The ship is equipped to undertake short tow operations when assisting other vessels through ice.

Searchlights and other high intensity illuminations are available for work during winter darkness.

Complement 131: 49 officers and 82 other ranks.

Power is supplied by two pressurized water nuclear reactors using enriched Uranium fuel rods.

Each reactor weighs 160 tonnes, both are contained in a closed compartment under reduced pressure.

Fuel consumption is approximately 200 g per day of heavy isotopes when breaking thick ice. 500

kg of Uranium isotopes are contained in each reactor when fully fueled. This allows about 4 years between changes of the reactor cores.

Shielding of the reactor is by steel, high density concrete and water. The chain reaction can be stopped in 0.6 seconds by full insertion of the safety rods.

Used cores are extracted and new ones installed in Murmansk, spent fuel is reprocessed, and waste is disposed of at a nuclear waste plant.

Ambient radiation is monitored by 86 sensors distributed throughout the vessel. In accommodation areas this is 10 to 12 μ Röntgen/hr, within the reactor compartment, at 50% power, 800 μ Röntgen/hr.

The primary cooling fluid is water, which passes directly to four boilers for each reactors; steam is produced at 30 kg/cm² (310°C).

Main propulsion system: each set of boilers drives two steam turbines that turn three dynamos (thus six dynamos may operate). 1 kV dc is delivered to three double-wound motors connected directly to the propellers.

Electricity for other purposes is provided by five steam turbines turning dynamos that develop a total of 10 MW.

There are three propellers; starboard and midships ones turn clockwise, port turns counter-clockwise. Shafts are 20 m long. Screw velocity is between 120 and 180 rpm.

Propellers are fixed, 5.7 m diameter and weigh 50 tonnes; each has four 7-tonne blades fixed by nine bolts (16 tonne torque applied); inspection wells allow them to be examined in operation.

Four spare blades are carried; diving and other equipment is aboard so a blade may be replaced at sea; each operation takes from 1 to 4 days (three such changes have been necessary on *Rossiia* icebreakers since 1985).

A propulsive effort of 480 tonnes can be delivered with 18-43 MW (25,000 shaft horsepower) from each screw (total 55.3 MW [75,000 shaft horsepower]).

Power can be controlled at a rate of 1% a second. Maximum speed is 22 knots (40 km/hr); full speed in open water is 19.5 knots (35 km/hr); breaking ice 2-3 m thick can be done at 3 knots (5.5 km/hr) continuously.

Maximum ice thickness that can be penetrated while navigating is estimated as 5 m; individual ridges estimated at 9 m thick have been broken through.

Helm controls one rudder, which turns 35° either way, operated by four hydraulic cylinders powered by one of two pumps. It is protected by an ice-horn for moving astern.

Steering may also be provided by directing air jets of the bubbling system (comparable to use of bow-thrusters).

Auxiliary power is available from three diesel generating sets: 1 MW (1×) and 250 kW (2×).

Anchors: two 7-tonne anchors with 300 m of chain each, and four ice anchors.

Four deck cranes are aboard; the largest pair can lift 16 tonnes each.

Sea water distillation: two vacuum stills can supply 5 m³ of fresh water an hour each (240 m³/day).

Differential ballast tanks are suitable fore and aft, and athwart the ship; the pumps are capable of moving 1 m³ of water a second.

Ship has 1280 compartments (cabins, storage areas, machine rooms, etc.).

Sufficient provisions and supplies can be carried to operate for 7 months.

Safety equipment includes: 1 launch, 2 fully enclosed lifeboats, and 18 inflatable life rafts.

**APPENDIX B: AN INVENTORY OF EXISTING SHIPS THAT ARE CAPABLE OF
NAVIGATING IN AT LEAST 0.3-m-THICK ICE COVER**

(Inventory compiled by Leonid Tunik)

TABLE OF CONTENTS

INTRODUCTION	36
REGULATORY AGENCIES	36
REGULATIONS	37
SHIPS INCLUDED	37
SCOPE OF DATA	38
NOTES TO THE PRINTED EDITION	39
NOTES TO THE ELECTRONIC EDITION	40
DATABASE FILE STRUCTURE	40
<i>LIST OF TABLES INCLUDED</i>	<i>40</i>
<i>MAIN TABLE DESCRIPTIONS</i>	<i>40</i>
<i>LOOK-UP TABLE DESCRIPTIONS</i>	<i>43</i>
<i>TABLE RELATIONSHIPS</i>	<i>44</i>
ACRONYMS USED	45
<i>REGISTER NAMES</i>	<i>45</i>
<i>BOW SHAPE</i>	<i>45</i>
<i>COUNTRY</i>	<i>45</i>
<i>SHIP TYPES</i>	<i>46</i>
<i>PROPULSION MACHINERY</i>	<i>46</i>
BIBLIOGRAPHY	47
INDEX OF SHIP SERIES BY ICE RANK	51
INDEX OF SHIPS WITH SERIES NAME	54
LIST OF SERIES AND SHIPS WITH SPECIFICATIONS	60
LIST OF SHIP OWNERS WITH SHIP NAMES	225

INTRODUCTION

This database has been developed in order to provide a user with an inventory of operating ships capable of navigation and marine trade over the Northern Sea Route (NSR) in the Russian Arctic, as well as in other ice-infested Arctic and Antarctic waters. Since the NSR, also known as the North-East Passage, is situated entirely within the Russian national waters, all navigation along the route is regulated by Russian authorities. Several regulatory and administrative agencies are involved, both directly and indirectly.

REGULATORY AGENCIES

NORTHERN SEA ROUTE ADMINISTRATION

The Moscow-based Northern Sea Route Administration, Dept. of Marine Transport, Ministry of Transportation, is the agency authorized to issue and publish official state regulations for navigation on the NSR. Since the Route has only recently been opened to foreign ships and mariners, the Administration issued its first "Regulations for Navigation on the Seaways of the Northern Sea Route" in 1991. The NSR Administration is also responsible for issuing and withdrawing permits for all non-Russian-flag and non-Russian-Register-classed ships passing throughout the route, as well as for issuing and withdrawing permits for the captains and mates to pilot the non-Russian ships in ice-infested waters on the route. The Administration is a regulatory body that does not control day-to-day operations on the NSR.

STAFFS OF MARINE OPERATIONS (SMO)

Traffic in ice-covered waters of the NSR is usually maintained year-round over the Western part of the route—the Barents and Kara Seas and Enisey Bay. The Eastern part is maintained from spring to early winter. The traffic usually involves more than a hundred ships over the entire route during the summer season, and falls to several dozen ships during the winter season. Day-to-day control of this traffic in ice conditions is carried out jointly by two executive offices of Staff of Marine Operations (SMO): the Dickson-based Western SMO and Pevek-based Eastern SMO, both controlling their respective parts of the route. The SMO offices are mainly comprised of the major shipping companies and include representatives from the NSR Administration, local administrations, supporting organizations (Hydro-Meteorological Service, Polar Aircraft and Helicopter Companies, Fuel Suppliers, etc.), and Navy liaisons. The major responsibilities of the Staffs include organization of caravans escorted by icebreakers, coordination of icebreaker operations over the route to maintain navigable channels, distribution of real-time information on ice-hydro-meteorological conditions over the route, management of emergency situations, coordination of piloting service, etc.

MURMANSK SHIPPING CO., FAR-EASTERN SHIPPING CO.

Murmansk Shipping Company (MSC), based in Murmansk, and Far-Eastern Shipping Company (FESC), based in Vladivostok, are owners of the world's largest Polar icebreaker fleet. Together they own more icebreaking gross tonnage and total shafthorsepower than the rest of the world combined. All nuclear-powered icebreakers and the only nuclear-powered icebreaking cargo vessel are owned by MSC.

RUSSIAN REGISTER OF SHIPPING (RR)

Russian Register of Shipping (Morskoi Reghistr Rossiiskoi Federatsii), based in St. Petersburg, is not involved in issuing the permits for navigation on the NSR. However, this agency may be requested

to evaluate the adequacy of ice strengthening of a particular ship in the framework of RR ice classification.

THE NAVY

The Russian Navy is not directly involved in the process of issuing permits and controlling navigation. However, any permit to a non-Russian ship has to be approved by a regional Naval office.

REGULATIONS.

NSR Administration published an official document stating the regulations governing the navigation on the NSR, entitled: Regulations for Navigation on the Seaways of the Northern Sea Route, (Moscow, 1991, hereafter referred to as NSR Regulations). The document outlines the general requirements and procedures for obtaining permits for entry to the NSR waters by non-Russian ships. The document refers to two other documents entitled: Requirements for the Design, Equipment and Supply of Vessels Navigating the NSR (Moscow, 1991, hereafter referred to as NSR Requirements), and Guide for Navigation Through the NSR (hereafter referred to as NSR Guide). The NSR Guide has not yet been published as of June 30, 1994. The NSR Requirements explicitly state that navigation on the NSR is allowed only for ships strengthened to ice categories L1, UL and ULA of Russian Register's Rules for Classification and Construction of Sea-Going Ships, (1990, hereafter referred to as RR Rules), or their equivalents in the Rules of other classification societies (see Table). This requirement is in accord with the definition of ice categories given by the RR Rules, which defines ice category L1 as the lowest class suitable for independent Arctic navigation in light summer ice conditions only. Technically, the NSR Requirements do not close the door for ships of lower ice categories (L2 and L3 of Russian Register Rules), but highly discourage them from applying for permits, hindering the permission for those ships by many "ifs", "special considerations" and higher fees.

Table 1. Inter-Register ice class equivalence, as defined in NSR Regulations.

	UL & equivalent	L1 & equivalent
GL	E4	E3
LR	I*, IA Super	I, IA
BV	I Super, IA Super	I, IA
DNV	1A*, 1A*F	1A
ABS	A1, IAA	A0, IA
RI	RGI*, IAS	RGI, IA
NKK	AA, IA Super	A, IA
FSIR	IA Super	IA

SHIPS INCLUDED

The restrictions made by the "Russian Requirements", and the design of this directory for marine traders dictate that the ships included be limited by the level of ice strengthening (ice class) and the type of ship. Above the ice class equivalence defined above in Table 1 a relative ranking table of all ice classes fit for navigation on the NSR (see Table 2) has been compiled for this database. All ships of ranks 1 and 2, virtually all ships of rank 3, and a great majority of rank 4 were included, based on their ice capabilities.

Table 2. Ice class ranking and equivalence by register.

	Rank 1	Rank 2	Rank 3	Rank 4
RR	LL1, LL2, LL3	LL4, ULA	UL & equivalent	L1 & equivalent
GL	Arc4, Arc3, Arc2	Arc1		
LR	AC3, AC2, AC1.5	AC1		
DNV	Polar-30, Polar-20	Polar-10, Ice-15, Ice-10		
ABS	A5, A4, A3	A2	A	B
CASPPR	10, 8, 7, 6, 4	1, 2		

The types of ships included are: commercial cargo vessels designed for marine trade, purpose icebreakers of non-military ownership, and scientific icebreaking ships. Specific type categories are listed in the Index Section of the report. For the sake of completeness, the U.S. and Canadian Coast Guard icebreakers are also included, as well as icebreakers owned by other governments. With regard to the ice class, the inventory includes: (a) icebreakers of all ice classes with an exception of, perhaps, some small ones intended for operations within ports, shallow rivers and small lakes; (b) virtually all ships strengthened to ice class of UL and above, or equivalent, and (c) a great majority of vessels of ice class L1 and its equivalent. Some ships included in this database have been recently decommissioned.

SCOPE OF DATA

The data for each vessel include vessel name, flag, ownership, home port, type of ship, principal dimensions, displacement, tonnage, cargo capacity, type and principal characteristics of propulsion machinery and propellers, ice propulsion capabilities, crew, special features enhancing cargo handling and maneuvering during mooring, fuel consumption rates where available, and itemized operating costs where available. Beyond these, other data which are deemed useful may also be added, namely: registry, general class notation and the assigned ice class (category), year and country of construction, former names, special features enhancing ice capabilities (unconventional shapes, water jet washing system, low friction-abrasion coating, etc.) for icebreakers and icebreaking Arctic cargo ships only.

NOTES TO THE PRINTED EDITION

MAIN LISTING

The Printed Edition of this database is designed for a reader looking for available ships of a certain type and ice class. Thus, ships of the same series are listed together in the same record, and the records are ordered alphabetically by the name of the series. Non-serial ships are treated as a series of one ship. The first part of a record contains information common to all the ships in the series: the name of the series, ice class, type of ship, principal specifications, and any modifications in the design of the series since the commission of the first ship. Then the particular ships belonging to that series are listed in alphabetical order with their respective information such as the name of the ship, flag, owner's name, register, year of commission, costs of operation and lease (where available), and any modernizations made to the ship after its commission.

OWNERS LISTING

Owners of the ships are listed alphabetically. The listings contain the owner's company name, address, telephone, fax, and telex. See the Index section for a list of ships by a particular company.

INDICES

There are indices for those who are looking for a particular ship by its name or by ice capability.

NOTES TO THE ELECTRONIC EDITION

The database is supplied in two electronic forms: 1) a set of normalized tables for incorporation into a larger database project and 2) a non-normalized table designed for immediate browsing and statistical analysis. The latter is an ASCII text file delimited with quotes and separated with commas, ready for importing into a spreadsheet program. The former is described below.

DATABASE FILE STRUCTURE

The data in the table files included have been normalized as much as was feasible for a compromise between ease of export and for integration into a larger project. The Main Tables described below contain the information about the ships, series, and owners, while the Look-up Tables contain the explanations of reference codes used in the Main Tables, e.g. Register names, ship type codes etc. Some fields in different tables have been given identical names for ease in incorporation into a relational database. Following are brief descriptions of each table, and a layout of their relationships in a schematic form.

LIST OF TABLES INCLUDED

MAIN TABLES:

SERSPECS
SISTERS
COMPANY
SHTYPE
ICERANK

LOOK-UP TABLES:

BOW
REGISTER
PROPMACH
COUNTRY
TYPE

MAIN TABLE DESCRIPTIONS

Following is the breakdown of the structure of each table, including the field name, type, length, number of decimal places if numeric, and index direction, as well as a brief description of the contents and units used in data entry. Memo types are generally fields that require more than 50 characters, such as descriptions of special equipment, modifications, cost information etc.

SERSPECS

SERSPECS contains information that is essentially the same for ships of the same series. This includes ice rank and class, principal dimensions and characteristics, and auxiliary features and systems common for the entire series, as well as information about modifications introduced after some ships had already been built. Each record is uniquely identified by field SERNUM (4 digits, character format), the reference number for the entire series of ships. The records in this table do not actually represent particular ships, only a set of specifications that corresponds to a set of ships. Thus, there is no field for ship name in this table.

Field Name	Type	Width/ Dec	Index	Description
SERNUM	Char	4	Asc	Series ID number
MODIFIC	Memo	10		Modification description
SERIESNAME	Char	25	Asc	Name of the series
SERIESSIZE	Num	3/0		Size of the series
ICECLASS	Char	6		Ice class assigned
LOA	Num	6/2		Overall length, m.
LBP	Num	6/2		Length bet. perpendiculars or design waterline, m.
BMOLD	Num	6/2		Molded breadth, m.
BMAX	Num	6/2		Overall breadth, m.
DEPTH	Num	6/2		Depth, m.
DWL	Num	6/2		Molded draft at design waterline, m.
DARC	Num	6/2		Arctic draft, m.
DMAX	Num	6/2		Max. draft, m.
DISPL	Num	7/0		Displacement at design draft, t.
DISPLARC	Num	7/0		Displacement Arctic draft, t.
DISPLMAX	Num	7/0		Displacement at max. draft, t.
DWT	Num	7/0		Deadweight at design draft, t.
DWTARC	Num	7/0		Deadweight at Arctic draft, t.
DWTMAX	Num	7/0		Deadweight at max. draft, t.
GROSS	Num	7/0		Gross tonnage, t.
CARGO	Char	50		Total cargo capacity, units incl.
BOWSHAPE	Char	4		ID code identifying the bow shape
STEMANG	Num	3/0		Stem inclin. angle to the waterline at DWL, deg.
PROPPWR	Num	6/0		Power at the propellers, kW
MACHPWR	Num	6/0		Power of the ship's machinery at flanges
THRUST	Num	6/0		Thrust of propellers in bollard conditions, tf
PROPMACH	Char	4		ID code identifying machinery type
PROPNUM	Num	1/0		Number of propellers
PWRDIST	Char	10		Power distribution among propellers
PROPTYPE	Char	16		Type of propellers
PROPDIAM	Num	4/2		Diameter of the propellers, m.
PROPBIDS	Char	20		Number of blades in the propeller
NOZZLES	Char	2		Availability of propeller nozzles
NOMSPD	Num	5/2		Nominal speed, kn.
RANGE	Char	20		Nominal range, units incl.
FUELCAP	Char	10		Maximum fuel capacity, units incl.
ICECAP	Char	50		Ice breaking capacity, m.@kn.
AUXSYS	Memo	10		Auxiliary icebreaking systems
CREW	Num	3/0		Number of crew members
THRUSTERS	Char	2		Availability of bow thrusters
FUELRATE	Char	12		Fuel consumption rate, units inc.
HELI	Memo	10		Availability of helicopter
SPECFEATR	Memo	10		Special features other than auxiliary icebreaking systems
UNLOADEQ	Memo	10		Equipment for unloading on unequipped shore
COMMENTS	Memo	10		General comments
REFERENCES	Memo	10		Literature for further information

SISTERS

SISTERS contains information that is unique to each particular ship. This includes the names of the ship, shipyard, register and owner, flag, costs, and special features and modifications peculiar to that ship. The records in this table are uniquely identified by field SHIPNUM (4 digits, Char format)

(whose values bear no connection to SERNUM from SERSPECS, though they are of the same format for the sake of simplicity). This table does not duplicate any information contained in SERSPECS.

Field Name	Type	Width	Index	Description
SHIPNUM	Char	10		ID number of the ship
NAME	Char	50	Asc	Name of the ship
SERNUM	Char	4		ID number of the series the ship belongs to
FIRST	Y/N	1		First in a series or not
EXNAMES	Char	50		Former names
ICEREG	Char	4		Ice register which assigned ice class to the ship
SHIPYARDID	Char	8		ID number of the shipyard
REGISTER	Char	4		Register, if other than Ice Register
FLAG	Char	4		Flag of the ship
REGNUMBER	Char	10		Register number from Lloyd's Register of Shipping
OWNERID	Char	8		ID of the owner company
HOMEPORT	Char	50		Home port
YRBUILT	Num	4/0		Year built
MODERNIZ	Memo	10		Modernizations description and year
OPCOSTS	Memo	10		Operational costs
CHRTRATE	Memo	10		Charter rate
SPECFEATR	Memo	10		Special features particular to the ship
NOTES	Memo	10		General notes

COMPANY

COMPANY contains information about the owners and shipyards. Each record is given a unique 6-Char ID composed of a combination of letters taken from the company name. The formula used for making the ID is as follows:

- Exclude following words: "Co", "Ltd", "Inc.", "&", "and", as well as prepositions and articles;
- Take the first 4 Chars of first word, or whole word if less than 4 Chars long;
- Add the first letter of the second word, or fill to 6 chars if only two words in the name;
- Add the first letter of the third word of the name.

Field Name	Type	Width	Index	Description
OWNERID	Char	8		ID number identifying the company
COMPANY	Char	50	Asc	Name of the company
CONTACT	Char	30		Contact name
ADDRESS1	Char	50		First line of address
ADDRESS2	Char	50		Second line of address
CITY	Char	40		City
STATE PROV	Char	30		State or province
ZIP POSTAL	Char	10		Zip code or postal code
COUNTRY	Char	25		Country
TEL	Char	20		Telephone
FAX	Char	20		Fax
EMAIL	Char	25		Electronic mail
TELEX	Char	16		Telex

SHTYPE

SHTYPE assigns ship types to the ships in the SISTERS table. There will be more than one type assigned to some ships, so this table is on the "many" side of a 1-to-many relationship with the SISTERS table. Each record of the table contains a SHIPNUM and one corresponding SHTYPE code. The description of each SHTYPE code can be looked up in the TYPES table.

Field Name	Type	Width	Index	Description
SERNUM	Char	4	Asc	Series ID number
SHTYPE	Char	20		Type of ship corresponding to the series

ICERANK

ICERANK assigns an internal relative ice rank to each ice class contained in field ICECLASS of SERSPECS. This lookup table uses the information given in Table 2. Ice class ranking and equivalence by register.

Field Name	Type	Width	Index	Description
REGID	Char	4	Asc	ID for the ice register
REGNAME	Char	50		Name of the register
ICECLASS	Char	10		Ice class
ICERANK	Char	1		Ice rank assigned

LOOK-UP TABLE DESCRIPTIONS

BOW

BOW is a look-up table of bow shape codes used in the BOWSHAPE field of the parent SERSPECS table.

Field Name	Type	Width	Index	Description
BOWSHAPE	Char	4	Asc	ID code for the shape of the bow
SHAPE	Char	70	Asc	Description of the shape of the bow

REGISTER

REGISTER is a look-up table of register codes used in field REGISTER of SISTERS

Field Name	Type	Width	Index	Description
REGACR	Char	4	Asc	ID code for the register name
REGISTER	Char	30		Register name

PROPMACH

PROPMACH is a look-up table of machinery types used in field PROPMACH of SERSPECS.

Field Name	Type	Width	Index	Description
PROPMACH	Char	4	Asc	ID code for the type of propulsion machinery
MACHINERY	Char	35	Asc	Type of propulsion machinery

COUNTRY

COUNTRY is a look-up table of country codes used in field FLAG of SISTERS

Field Name	Type	Width	Dec	Description
CO	Char	2	Asc	ID code for the country
COUNTRY	Char	35		Country name

TYPES

TYPES is a look-up table of ship type codes contained in field SHTYPE of the SHTYPE table

Field Name	Type	Width	Index	Description
SHIPTYPE	Char	4	Asc	ID code for ship type
TYPE	Char	50		Ship type

TABLE RELATIONSHIPS

From table/field	To table/field	Relationship
SISTERS table SERNUM field ▷	SERSPECS table SERNUM field	1 to 1
OWNERID field ▷	OWNER table OWNERID field	1 to 1
SHIPYARDID field ▷	SHIPYRDS table SHIPYARDID field	1 to 1
REGISTER field ▷	REGISTER table REGACR field	1 to 1
FLAG field ▷	COUNTRY table CO field	1 to 1

From table/field	To table/field	Relationship
SERSPECS table ICECLASS field ▷	RANKING table ICECLASS field	1 to 1
PROPMACH field ▷	PROPMACH table PROPMACH field	1 to 1
BOWSHAPE field ▷	BOWSHAPE table BOWSHAPE field	1 to 1
SERNUM field ▷	SHTYPE table SERNUM field	1 to 1

From table/field	To table/field	Relationship
SHTYPE table ICECLASS field ▷	TYPES table SHIPTYPE field	1 to Many

ACRONYMS USED

REGISTER NAMES

ABS	American Bureau of Shipping
BV	Bureau Veritas
CR	Canadian Arctic Shipping Pollution Prevention Regulations (CASPPR)
DNV	Det Norske Veritas
FR	Finnish-Swedish Ice Rules (FSIR)
GL	Germanischer Lloyd
LR	Lloyd's Register of Shipping
NKK	Nippon Kaiji Kuokyo
RI	Registro Italiane Navale
RR	Russian Register

BOW SHAPE

CONS	Conventional plain wedge with straight-line stem and bottom stopper
CONV	Conventional plain wedge with straight-line stem
CONC	Conventional wedge with curvilinear line stem and bottom stopper
SPOO	Spoon-shaped
THYS	Thyssen-Waas
SLED	Sledge shaped
SLOP	Sloped plane with wedge

COUNTRY

AL	Australia	JP	Japan
AR	Argentina	LB	Liberia
AS	Austria	LH	Lithuania
AZ	Azerbaijan	LT	Latvia
BH	Bahamas	ML	Malta
BL	Bulgaria	NR	Norway
CN	Canada	PL	Poland
CY	Cyprus	PN	Panama
ES	Estonia	RC	Republic of China
FN	Finland	RF	Russian Federation
GB	Great Britain	RM	Romania
GC	Greece	SP	Spain
GN	The Grenadines	SW	Sweden
GO	Republic of Georgia	TR	Turkey
GR	Germany	UK	Ukraine

HG Hungary

US U.S.A.

SHIP TYPES

ASRV Antarctic supply research vessel
BULK Bulk carrier
CGIB Coast Guard icebreaker
CHEM Chemical transport
CONT Container carrier
DRED Dredge
DRIR Drilling rig
DRIS Drilling ship
FERR Ferry
HLV Heavy lift vessel
IB Purpose Icebreaker
LASH LASH & container carrier
MPC Multi-purpose cargo
MPIB Multi-purpose icebreaker
MSH Mother ship for submersibles

OTHE Other type
PASS Passenger
PATR Patrol boat
PIB Polar icebreaker
REFR Refrigerator
RIB River icebreaker
RORO Roll on - Roll off
RV Research vessel
SALV Salvage tug
SUBM Submersible
SUPP Supply ship
SWIB Shallow-water icebreaker
TANK Tanker
TIMB Timber carrier
TUG Tug

PROPULSION MACHINERY

DIEL Diesel-electric
MSDG Medium-speed Diesel-gearred
NPTE Nuclear-powered Turbo-electric
SSDG Slow-speed Diesel-gearred
TUEL Turbo-electric

BIBLIOGRAPHY

- Andryushin, Y., D. Solostyansky, 1986, The "Akademik Fedorov", "Morskoi Flot", 1986, #11, p60-62.
- Bognenko, F.M., V.A. Pankov, 1981, The LASH "Alexey Kosygin", "Sudostroenie", 1981, #12, p3-9.
- Canadian Arctic Shipping Pollution Prevention Regulations, "Canada Gazette", 1972. Part II, vol 1, 106, No. 20.
- Dick, R.A., J.E. Laframboise, 1989, An Empirical Review of the Design and Performance of Icebreakers, "Marine Technology", vol.26, No.2, April 1989, p145-159.
- Dvorovenko, V., 1986, The Chemicals Carrier "Alexander Kaverznev", "Morskoi Flot", 1986, #8, p40-43.
- Elisavetchenko, V., 1983, The Drill-Ship "Valentin Shashin", "Morskoi Flot", 1983, #3, p47.
- Finnish-Swedish Ice Rules, Finnish-Swedish Board of Navigation, 1986.
- Glebko, Y., 1992, Efficiency Study of the "Vitus Bering"-Class Supply Ships, Trans. CNIIMF "Achitectural-Structural Type, Sea- and Ice-Worthiness of Cargo Ships", 1992, p103-116.
- Ivanov, S.N., L.Y. Brzesovsky, et al, 1990, CPP of the Nuclear Powered LASH/Container Carrier "Sevmotput", "Sudostroenie", 1990, #2, p16-20.
- Kosovsky, S. B., A.A. Karmanov, 1988, The Arctic Supply Vessel "Vitus Bering", "Sudostroenie", 1988, #5, p3-6.
- MER Jan1994, 1994, Canadian Icebreaker's Steam-Turbo Conversion to Diesel-Electric, "MER", January 1994, p34-36.
- Narby, R., 1984, Propellers for Soviet Arctic Ships: Lessons from Initial Experience, "Marine Engineering/LOG", February 1984, p31-39.
- Nikonov, O., Y.Pronin, 1984, The Universal Dry Cargo MV "Vitaly Demianchenko", "Morskoi Flot", 1984, #7, p42-45.
- Orlano-Erenya, 1981, The Deisel-Geared Icebreaker "Mudyug", "Sudostroenie", 1981, p3-5.
- Petrakov, E.V., 1990, Modernization of the "Kapitan Sorokin" Class Icebreakers, "Sudostroenie", 1990, #10, p3-5.
- Rabazov, Y.N., 1990, A New Dry Cargo Carrier for the Siberia and Far East, "Sudostroenie", 1990, #6, p3-6.
- Regulations for Navigation on the Seaways of the Northern Sea Route, NSR Administration, Moscow, 1991.

- Requirements for the Design, Equipment, and Supply of Vessels Navigating the NSR, NSR Administration, Moscow, 1991.
- Rules for Classification and Construction of Sea-Going Vessels, Russian Register, "Transport" Publishing House, St. Petersburg, 1990.
- Rules and Regulations for the Classification of Ships, Lloyd's Register of Shipping, 1992.
- Rules for Classification of Steel Ships, Det Norske Veritas, 1988.
- Rules for Classification and Construction. Ship Technology. Germanischer Lloyd, 1992.
- Rules for Classing and Building of Steel Vessels, American Bureau of Shipping, 1992.
- Semenov, S., 1986, The MV "Anatoly Kolesnichenko", Morskoi Flot, 1986, #5, p43-47.
- Sheidorov, V.V., V.I. Yushin, 1990, The Research Vessel "Akademik Ioffe" with Sail Assisted Propulsion, Sudostroenie, 1990, #3, p3-7.
- Simonov, Y.A., G.M. Koval, 1989, Trends in Development of Icebreakers and Cargo Ships Navigating in Ice, Sudostroenie, 1989, #7, p3-6.
- SW&S, 1992, Ice Technology Advancing Slowly. "Kapitan Sorokin". "Fennica", Multipurpose Icebreaker Launched, Shipping World & Shipbuilding, October 1992, p30-32.
- SW&S-a, 1993, Ice-Going Ships, Shipping World & Shipbuilding, November 1993, p13-16.
- SW&S-b, 1993, "Fennica" Revolutionary Icebreaker, Shipping World & Shipbuilding, June 1993, p13-16.
- Sytov, N.P., N.N. Rodionov, V.I. Zimin, 1981, Design of a Nuclear-Powered Icebreaking LASH/Container Carrier, Sudostroenie, 1981, #11, p3-7.
- Thompson, W., 1993, Dual Role: Single Entity. The "Fennica", The Motor Ship, January 1993, p40-43.
- Tsoy, L.G., A.K. Sinyaev, 1989, Nuclear-Powered Shallow-Water Icebreaker "TAIMYR", Sudostroenie, 1989, #7, p6-9.
- Tsoy, L.G., 1990, Formula for Determining Ice Propulsion Capability and Recommendations for Selecting the Hull Lines of Icebreakers and Cargo Ships Navigating in Ice, Trans. CNIIMF "Achitectural-Structural Type, Sea- and Ice-Worthiness of Cargo Ships", 1990, p141-144.
- Tsoy, L.G., 1992, State-Of-The-Art and Prospects of Development of Sea-Going Icebreakers, Trans. CNIIMF "Achitectural-Structural Type, Sea- and Ice-Worthiness of Cargo Ships", 1992, p11-38.
- Tsoy, L.G., D.D. Maxutov, A.D. Zimin, 1993, Arctic Fleet and Its Future, Sudostroenie, 1993, #11-12, p16-19.
- Vinogradov, A.A., A.V. Vinogradov, 1993, The New Series of 4600 DWT Timber Carriers, "Sudostroenie", 1989, #2-3, p3-7.

Wind, J., 1984, The Dimensioning of High Power Propeller Systems for Arctic Icebreakers and Icebreaking Vessels, "International Shipbuilding Progress", April 1984,p105-117, and May 1984, p131-147.

Zakharov, B.N, E.V. Petrakov, 1987, Enhancing Ice Propulsion Capabilities of the Icebreaker "Mudyug", "Sudostroenie", 1987, #12, p6-10.

ALSO SCHEDULED FOR PUBLICATION

Guide for Navigation on the NSR, NSR Administration, Moscow.

SERIES NAME	SERIES SIZE	LBP	Bmold	DWL	POWER
Highland Sentinel		60.39	12.80	4.77	5176
IgarkaLes	9	93.28	14.00		2130
Ilyich	1	115.80	22.00	5.42	13240
Jaguar		80.40	15.63	5.90	
Kapitan Gavrilov	10	192.73	25.40		15660
Kapitan Lus		89.40			3360
Kapitan Panfilov	11	134.40			4930
Kiisla		105.20	17.60	6.60	3700
Komandor	4	82.20	13.60	4.70	56704
Kosmonavt Pavel Beliyev		113.00	16.69		3825
KotlasLes	15	93.00	14.00		2130
Krymsk	21	94.50			2130
Krystall	1	142.00	22.00		7600
LadogaLes	6	93.02	13.85	5.91	2133
Marinor		104.66	18.00	7.50	
Mariya Yermolova		90.00	16.21	4.65	38821
Mary Christina		84.90		5.30	1850
Mekhanik Yartsev	10	79.40	14.20	4.70	2074
Mikhail Kalinin		109.99	15.96		6106
Mirnyy	46	93.02	14.00	6.20	2133
Nikolay Novikov	25	139.86			7060
Nikopol	6	74.00			1470
Novaya Ladoga (Pr. 596)		113.01	16.69	5.99	3825
Novy Donbass	2	90.00	13.90		1840
Petrozavodsk	20	112.78	16.69		3825
Pioner	30	96.00	15.60		2390
Posiet	4	93.40	17.00		7502
Povenets	23	96.00	14.60		2390
Professor Goryunov		101.00		6.50	7156
Rheinstern	4	153.00		8.50	6600
Seapower		60.39	12.80	4.77	5176
Sergei Kirov	2	142.00	23.80		8700
Shuhle Geteborg		82.50		3.60	2370
SibirLes	12	94.50	14.33		2130
Sibirski					
Sosnovets	11	71.20			1100
Sovetskaya Yakutiya	8	117.00	15.00		1472
Sovetskii Voin	20	74.21	12.48	5.40	1839
Spartak	14	69.74	11.50		1100
Stakhanovets Kotov	2	121.00	20.20		4810
SukhonaLes		93.91	14.33	5.78	1471
Svetlomor-1		51.80	14.00	4.50	
Tebo Olimpia	1	132.80	21.20	7.30	5560
Temriuk		74.00	11.97	4.65	1471
Trans Dania		106.40	17.50	6.71	3000
Ulegorsk		90.22	17.30	5.62	3360
Viiralaia	5	70.80			1553
Vitalii Diakonov	11	116.96	15.80	4.50	2200
VolgoLes	4	115.00	16.70		3310
Weserster	2	104.60	17.70	8.54	
World Discoverer		72.70	15.20	4.46	3529

SHIPS v. SERIES NAME

A reference for finding the series listing for a particular ship

SHIP NAME	LISTED UNDER SERIES	SHIP NAME	LISTED UNDER SERIES
Abakan	Igor Ilyinski	Atle	Atle
Admiral Makarov	Yermak	Aurora Austrelis	Aurora Austrelis
Admiral Ushakov	Dmitry Donskoi	Ayan	SibirLes
Afanasiy Bogatyryov	Sovetskaya Yakutiya	Bakaritsa	Novaya Ladoga (Pr. 596)
Akademik Fedorov	Akademik Fedorov	Bakhchisaray	Balkhash
Akademik Ioffe	Akademik Sergei Vavilov	Balkhash	Balkhash
Akademik Nalivkin	Akademik Nalivkin	Baltic Press	Baltic Press
Akademik Pozdnyunin	Vitalii Diakonov	Baltic Print	Baltic Press
Akademik Sergei Vavilov	Akademik Sergei Vavilov	BAM	Samotlor
AlatyrLes	VolgoLes	Bars	Jaguar
Aldan	SibirLes	Baykal	Mikhail Kalinin
Aleksandr Dovzhenko	Aleksandr Dovzhenko	Baykonur	BelomorskLes
Aleksandr Fadeyev	Alexandr Fadeev	Belogorsk	Partizansk
Aleksandr Kaverznev	Aleksandr Kaverznev	BelomorskLes	BelomorskLes
Aleksandr Miroshnikov	Sovetskii Voin	Belomorye	Balkhash
Aleksandr Nevskiy	Dmitry Donskoi	Beloyarsk	Temriuk
Aleksandr Pankratov	Sovetskii Voin	Beryozovo	Samotlor
Aleksandr Prokofyev	Alexandr Fadeev	Blagoveshensk	Mirnyy
Aleksandr Suvorov	Dmitry Donskoi	Boris Nikolaychuk	Krymsk
Aleksandr Tvardovskiy	Alexandr Fadeev	Borya Tsarikov	Pioner
Aleksey Chirikov	Vitus Bering	Botsman Moshkov	Nikolay Novikov
Aleksey Kosygin	Alexey Kosygin	Bratsk	Norilsk (a.k.a. SA-15)
Alla Tarasova	Mariya Yermolova	Bukhtarma	Povenets
Almaz	Almaz	Canmar Explorer	Canmar Explorer
Almirante Irizar	Almirante Irizar	Canmar Explorer II	Canmar Explorer
AltayLes	BelomorskLes	Canmar Kigiriak	Canmar Kigiriak
Amderma	Norilsk (a.k.a. SA-15)	Chazhma	Mirnyy
Anadyr	Norilsk (a.k.a. SA-15)	Chekhov	Ulegorsk
Anatoliy Kolesnichenko	Anatoliy Kolesnichenko	Cherepovets	Sosnovets
Anatoliy Lyapidevskiy	Mikhail Strekalovski	Dallnerechensk	Ventspils
Anatoliy Sibiryakov	Pavlin Vinogradov	Darasun	BelomorskLes
Andrey Ivanov	Sovetskii Voin	Daugava	Ventspils
Angarsk	Partizansk	De Kastri	Ulegorsk
Anna Akhmatova	Anna Akhmatova	Dikson	Mudyug
Anna Karenina	Anna Karenina	Discoverer 534	Discoverer 534
Anton Buyukly	Krymsk	Discoverer Seven Seas	Discoverer 534
Antonina Nezhdanova	Mariya Yermolova	Discovery	Discovery
Aranda	Aranda	Dmitriy Ovtsyn	Dmitriy Ovtsyn
Arctic	Arctic	Dmitriy Pozharskiy	Dmitry Donskoi
Arctic Tuktu	Arctic Tuktu	Dmitriy Sterlegov	Dmitriy Ovtsyn
Arcticshelf	Arcticshelf	Dmitry Donskoi	Dmitry Donskoi
Arkadiy Kamanin	Pioner	Drogobych	Drogobych (Ocean A/B)
Arkhangelsk	Norilsk (a.k.a. SA-15)	Dunker	Dunker
Arktika	Arktika	DvinoLes	VolgoLes
Arseniy Moskvina	Sovetskii Voin	Dzhurma	BelomorskLes
Arsenyev	Partizansk	Eduard Toll	Dmitriy Ovtsyn
Atlas	Almaz	Egvekinot	SibirLes

SHIP NAME	LISTED UNDER SERIES	SHIP NAME	LISTED UNDER SERIES
Elbestern	Emsstern	IzhmaLes	IgarkaLes
Elektrostal'	BelomorskLes	IzhoraLes	IgarkaLes
Emsstern	Emsstern	James Clark Ross	James Clark Ross
EPRON	Almaz	Jose Diaz	Mirnyy
Estonia	Mikhail Kalinin	Kaliningrad	Mirnyy
Fastov	Fastov	Kalvik	Terry Fox
Fennica	Fennica	KamaLes	IgarkaLes
Finnfellow	Finnfellow	Kamchadal	Mirnyy
Finnfighter	Finnfighter	Kamchatskiy Komsomolets	Mirnyy
Finnmaid	Finnfellow	Kamensk-Uralskiy	Samotlor
Finnmerchant	Finnmerchant	Kandalaksha	Norilsk (a.k.a. SA-15)
Franklin	Piere Radisson	Kansk	BelomorskLes
Frej	Atle	Kapitan A. Radjabov	Kapitan M. Izmailov
Frontier Spirit	Frontier Spirit	Kapitan Babichev	Kapitan Yevdokimov
Fyodor Litke	Vasilii Pronchishev	Kapitan Bakanov	Nikolay Novikov
Fyodor Matisen	Dmitriy Ovtsyn	Kapitan Beklemishev	Almaz
Fyodor Okhlopkov	Sovetskaya Yakutiya	Kapitan Belousov	Kapitan Belousov
Fyodor Popov	Sovetskaya Yakutiya	Kapitan Bochek	Mikhail Strekalovski
Fyodor Varaskin	Nikolay Novikov	Kapitan Borodkin	Kapitan Yevdokimov
Gastello	Ulegorsk	Kapitan Bukaev	Kapitan Chechkin
Gerakl	Gerakl	Kapitan Burmakin	Nikolay Novikov
Glomar Beaufort Sea I	Glomar Beaufort Sea I	Kapitan Chadaev	Kapitan Chechkin
Gorno-Altaysk	Posiet	Kapitan Chechkin	Kapitan Chechkin
Gornopravdinsk	Samotlor	Kapitan Chmutov	Kapitan Goncharov
Grosselier	Piere Radisson	Kapitan Chudinov	Kapitan Yevdokimov
Guryev	Partizansk	Kapitan Chukhchin	Mikhail Strekalovski
Guse-Khrustalnyi	Mirnyy	Kapitan Danilkin	Anatoliy Kolesnichenko
Henry Larsen	Henry Larsen	Kapitan Demidov	Kapitan Yevdokimov
Highland Sentinel	Highland Sentinel	Kapitan Djachuk	Drogobych (Ocean A/B)
Icha	Temriuk	Kapitan Dotsenko	Drogobych (Ocean A/B)
Igarka	Norilsk (a.k.a. SA-15)	Kapitan Dranitsyn	Kapitan Sorokin
IgarkaLes	IgarkaLes	Kapitan Dublitskiy	Nikolay Novikov
Igor Grabar	Igor Grabar	Kapitan Gastello	Mirnyy
Igor Ilyinski	Igor Ilyinski	Kapitan Gavrilov	Kapitan Gavrilov
Igrim	Samotlor	Kapitan Glazachev	Nikolay Novikov
Ikaluk	Ikaluk	Kapitan Glotov	Pavlin Vinogradov
Iljinsk	Mirnyy	Kapitan Gnezdilov	Kapitan Sakharov
Ilyich	Ilyich	Kapitan Goncharov	Kapitan Goncharov
Indiga	LadogaLes	Kapitan Gotskii	Kapitan Gotskii
Iogann Makhmatal'	Pavlin Vinogradov	Kapitan Kanevskiy	Kapitan Gavrilov
Irbis	Yasnyi	Kapitan Khlebnikov	Kapitan Sorokin
IrtysLes	IgarkaLes	Kapitan Kiriy	Nikolay Novikov
Isakogorka	Novaya Ladoga (Pr. 596)	Kapitan Kobets	Drogobych (Ocean A/B)
Isidor Barakhov	Sovetskaya Yakutiya	Kapitan Kondratjev	Kapitan Gotskii
Istra	IgarkaLes	Kapitan Kosolapov	Kapitan M. Izmailov
Ivan Bogun	Dmitry Donskoi	Kapitan Kozlovskiy	Kapitan Gavrilov
Ivan Bolotnikov	Spartak	Kapitan Krems	Kapitan Sakharov
Ivan Kireyev	Dmitriy Ovtsyn	Kapitan Krutov	Kapitan Chechkin
Ivan Kruzenshtern	Vasilii Pronchishev	Kapitan Kudlay	Mikhail Strekalovski
Ivan Makarjin	Mikhail Strekalovski	Kapitan Lus	Kapitan Lus
Ivan Moskvitin	Vasilii Pronchishev	Kapitan Lyubchenko	Nikolay Novikov
Ivan Papanin	Ivan Papanin	Kapitan M. Izmailov	Kapitan M. Izmailov
Ivan Shadr	Igor Grabar	Kapitan Malakhov	Kapitan Belousov
Ivan Strod	Sovetskaya Yakutiya	Kapitan Mann	Anatoliy Kolesnichenko
Ivan Susanin	Dmitry Donskoi	Kapitan Mecaik	Kapitan Yevdokimov
Ivan Syrykh	Nikolay Novikov	Kapitan Milovzorov	Nikolay Novikov

SHIP NAME	LISTED UNDER SERIES	SHIP NAME	LISTED UNDER SERIES
Kapitan Mochalov	Nikolay Novikov	Konstantinovka	Fastov
Kapitan Moshkin	Kapitan Yevdokimov	Kontio	Otso
Kapitan Myshevskiy	Kapitan Gotskii	Koporje	Mirnyy
Kapitan Nazarjev	Mikhail Strekalovski	Korsakov	SibirLes
Kapitan Nevezhkin	Drogobych (Ocean A/B)	Kosmonavt Pavel Beliaev	Kosmonavt Pavel Beliaev
Kapitan Nikolayev	Kapitan Sorokin	Kosmonavt V. Patsayev	Kosmonavt Pavel Beliaev
Kapitan Panfilov	Kapitan Panfilov	Kosmonavt V. Volkov	Kosmonavt Pavel Beliaev
Kapitan Plakhin	Kapitan Chechkin	KostromaLes	LadogaLes
Kapitan Ponomaryov	Pavlin Vinogradov	Kotlas	Partizansk
Kapitan Primak	Kapitan Goncharov	KotlasLes	KotlasLes
Kapitan Sakharov	Kapitan Sakharov	Kovdor	Povenets
Kapitan Samoylenko	Nikolay Novikov	Kozyrevsk	Mirnyy
Kapitan Sergiyevskiy	Kapitan Sakharov	Krasin	Yermak
Kapitan Shevchenko	Nikolay Novikov	Krasnoborsk	Mirnyy
Kapitan Shevtsov	Drogobych (Ocean A/B)	Krasnopolye	Krymsk
Kapitan Sorokin	Kapitan Sorokin	Krasnoturjinsk	Krymsk
Kapitan Sviridov	Mikhail Strekalovski	Krasnoyarsk	Mirnyy
Kapitan Tsurul'	Mikhail Strekalovski	Krymsk	Krymsk
Kapitan Vakula	Mikhail Strekalovski	Krystall	Krystall
Kapitan Vasilevskiy	Nikolay Novikov	Kulluk	Kulluk
Kapitan Vodenko	Mikhail Strekalovski	Kuloy	Novaya Ladoga (Pr. 596)
Kapitan Voronin	Kapitan Belousov	Kulunda	Krymsk
Kapitan Yevdokimov	Kapitan Yevdokimov	Kuzma Minim	Dmitry Donskoi
Kapitan Zamyatin	Nikolay Novikov	Kuzminki	Mirnyy
Kapitan Zarubin	Kapitan Chechkin	Kuznetsk	Krymsk
Kapitan Zavenyagin	Kapitan Yevdokimov	Ladogales	LadogaLes
Kapitan Zheltovskiy	Kapitan Sakharov	Lakhta	SibirLes
Karaga	Krymsk	Lara Mikheyenko	Pioner
Katangli	Krymsk	Lazurit	Almaz
Katmai Bay	Katmai Bay	Lena	Lena
Kavalerovo	Krymsk	Lenin	Lenin
Kem'	SibirLes	Leningrad	Moskva
Kemerovo	Norilsk (a.k.a. SA-15)	Leningradskiy Opolchenets	Sovetskii Voin
Khariton Laptev	Vasilii Pronchishev	Leningradskiy Partizan	Sovetskii Voin
Kharlov	Mirnyy	Libby G	Libby G
Khatanga	BelomorskLes	Ligovo	Mirnyy
Kholmsk	BelomorskLes	Lomonosovo	Mirnyy
Kiev	Moskva	Louis S. St. Laurent	Louis S. St. Laurent
Kiisla	Kiisla	Lunni	Lunni
Kikhchik	Mirnyy	Lyonya Golikov	Pioner
Kimry	Mirnyy	Lyubov Orlova	Mariya Yermolova
Kingisepp	Mirnyy	Magadan	Mudyug
Kirensk	Krymsk	Maksim Ammosov	Sovetskaya Yakutiya
Klavdia Yelanskaya	Mariya Yermolova	Marat Kazey	Pioner
Kola	Norilsk (a.k.a. SA-15)	Marinor	Marinor
Kolguyev	LadogaLes	Mariya Savina	Mariya Yermolova
Kolya Myagotin	Pioner	Mariya Yermolova	Mariya Yermolova
Komandor	Komandor	Mary Christina	Mary Christina
KomiLes	VolgoLes	Maymaksa	Novaya Ladoga (Pr. 596)
Komsomolets Sakhalina	Novaya Ladoga (Pr. 596)	Mekhanik Brilin	Mekhanik Yartsev
Kondratii Bulavin	Spartak	Mekhanik Fomin	Mekhanik Yartsev
Konstantin Korshunov	Sovetskii Voin	Mekhanik Gordienko	Nikolay Novikov
Konstantin Petrovskiy	Nikolay Novikov	Mekhanik Kotsov	Mekhanik Yartsev
Konstantin Savelyev	Sovetskii Voin	Mekhanik Makarjin	Mekhanik Yartsev
Konstantin Shestakov	Sovetskii Voin	Mekhanik Pustoshnyi	Mekhanik Yartsev
Konstantin Yuon	Igor Grabar	Mekhanik Pyatlin	Mekhanik Yartsev

SHIP NAME	LISTED UNDER SERIES	SHIP NAME	LISTED UNDER SERIES
Mekhanik Rybachuk	BelomorskLes	Palanga	Petrozavodsk
Mekhanik Yartsev	Mekhanik Yartsev	Pandora II	Pandora II
Mikhail Cheremnykh	Igor Grabar	Paramushir	Petrozavodsk
Mikhail Kalinin	Mikhail Kalinin	Pargolovo	Petrozavodsk
Mikhail Kutuzov	Dmitry Donskoi	Paromay	Petrozavodsk
Mikhail Prishvin	Alexandr Fadeev	Partizansk	Partizansk
Mikhail Somov	Mikhail Somov	Pavel Bashmakov	Dmitriy Ovtsyn
Mikhail Strekalovski	Mikhail Strekalovski	Pavel Korchagin	Pioner Moskv
Mikhail Svetlov	Alexandr Fadeev	Pavel Ponomaryov	Kapitan Gotskii
Mirnyi	Mirnyi	Pavel Shepelyov	Vitalii Diakonov
Miscaroo	Ikaluk	Pavel Vavilov	Mikhail Strekalovski
Molikpaq	Molikpaq	Pavlik Larishkin	Pioner
Monchegorsk	Norilsk (a.k.a. SA-15)	Pavlin Vinogradov	Pavlin Vinogradov
Moskva	Moskva	Pavlovo	Petrozavodsk
Mudyug	Mudyug	Pavlovsk	Sergei Kirov
Murman	Povenets	Pechenga	Petrozavodsk
Murmansk	Moskva	Perm'	Petrozavodsk
Nadym	Samotlor	Pertominsk	Petrozavodsk
Nagayevo	Ventspils	Pervouralsk	Mirnyi
Nathaniel B. Palmer	Nathaniel B. Palmer	Petrokrepost	Petrozavodsk
Nauka	Arcticshef	Petropavlovsk	Mikhail Kalinin
Navarin	Kapitan Gotskii	Petropavlovsk-Kamchatsk	Partizansk
NevaLes	LadogaLes	Petrovskiy	Petrozavodsk
Nevelsk	Ulegorsk	Petrozavodsk	Petrozavodsk
Nikel	Norilsk (a.k.a. SA-15)	Pierre Radisson	Piere Radisson
Nikolay Bauman	Spartak	Pioner	Pioner
Nikolay Dolinskiy	Vitalii Diakonov	Pioner Arkhangelska	Pioner Moskv
Nikolay Kantemir	Ulegorsk	Pioner Belorussii	Pioner Moskv
Nikolay Kolomeytsev	Dmitriy Ovtsyn	Pioner Buryatii	Pioner Moskv
Nikolay Novikov	Nikolay Novikov	Pioner Chukotki	Pioner Moskv
Nikolay Tikhonov	Kapitan Gavrilov	Pioner Estonii	Pioner Moskv
Nikolay Yemelyanov	Sovetskii Voin	Pioner Kamchatki	Pioner Moskv
Nikolay Yevghenov	Dmitriy Ovtsyn	Pioner Karelii	Pioner Moskv
Nikolayevsk	Mikhail Kalinin	Pioner Kazakhstana	Pioner Moskv
Nikopol	Nikopol	Pioner Kholmska	Pioner Moskv
Nina Kukoverova	Pioner	Pioner Kirghizii	Pioner Moskv
Nizhnevartovsk	Samotlor	Pioner Litvy	Pioner Moskv
Nizhneyarsk	Norilsk (a.k.a. SA-15)	Pioner Moldavii	Pioner Moskv
Nogliki	Ulegorsk	Pioner Moskv	Pioner Moskv
Norilsk	Norilsk (a.k.a. SA-15)	Pioner Nakhodki	Sestroretsk
Norse Mersey		Pioner Oneghi	Pioner Moskv
Novaya Ladoga	Novaya Ladoga (Pr. 596)	Pioner Primorya	Sestroretsk
Novokubansk	Ulegorsk	Pioner Rossii	Pioner Moskv
Novy Donbass	Novy Donbass	Pioner Severodvinska	Pioner Moskv
Oden	Oden	Pioner Slavyanki	Pioner Moskv
Oderstern	Weserstern	Pioner Uzbekistana	Pioner Moskv
Oka	Novaya Ladoga (Pr. 596)	Pioner Vladivostoka	Sestroretsk
Okha	Norilsk (a.k.a. SA-15)	Pioner Vyborga	Sestroretsk
Olenegorsk	Povenets	Pioner Yakutii	Pioner Moskv
Olga Sadovskaya	Mariya Yermolova	Pioner Yu. Sakhalinska	Pioner Moskv
Omolon	SibirLes	Pionerskaya Zor'ka	Pioner
Orehovo-Zuyevo	BelomorskLes	Platon Olunskiy	Sovetskaya Yakutiya
Orient Makarov	Ulegorsk	Plesetsk	Petrozavodsk
Otso	Otso	Pobedino	BelomorskLes
Otto Schmidt	Otto Schmidt	Polar Circle	Polar Circle
Palana	Mirnyi	Polar Duke	Polar Duke

SHIP NAME	LISTED UNDER SERIES	SHIP NAME	LISTED UNDER SERIES
Polar Sea	Polar Star	SevMorPut	SevMorPut
Polar Star	Polar Star	Shadrinsk	BelomorskLes
Polarstern	Polarstern	Shatura	BelomorskLes
Pomorje	Petrozavodsk	Shiraze	Shiraze
Ponoy	Petrozavodsk	Shkotovo	Partizansk
Poronaysk	Petrozavodsk	Shuhle Geteborg	Shuhle Geteborg
Poronin	BelomorskLes	Shura Kober	Pioner
Posyet	Posiet	Shushenskoye	Mirnyy
Povenets	Povenets	Sibir	Arktika
Primorje	Petrozavodsk	SibirLes	SibirLes
Professor Bubnov	Vitalii Diakonov	Sibirski 2101	Sibirski
Professor Goryunov	Professor Goryunov	Sibirski 2102	Sibirski
Professor Papkovich	Vitalii Diakonov	Sibirski 2103	Sibirski
Professor Tovstykh	Kapitan Gavrilov	Sibirski 2104	Sibirski
Professor Victor Vologdin	Vitalii Diakonov	Sibirski 2105	Sibirski
Professor Vladimir Popov	Vitalii Diakonov	Sibirski 2106	Sibirski
Professor Voskresenskiy	Vitalii Diakonov	Sibirski 2107	Sibirski
Przhevalsk	Petrozavodsk	Sibirski 2108	Sibirski
Pulkovo	Petrozavodsk	Sibirski 2109	Sibirski
Pushlakhta	Petrozavodsk	Sibirski 2121	Sibirski
Pustozersk	Petrozavodsk	Sibirsky	Stroptivyi
Pyotr Kakhovski	Spartak	Sibirtsevo	SibirLes
Pyotr Pakhtusov	Vasilii Pronchishev	Sisu	Atle
Pyotr Smidovich	Nikolay Novikov	Slautnoye	Sosnovets
Pyotr Strelkov	Nikolay Novikov	Slavyanka	Posiet
Pyotr Velikiy	Dmitry Donskoi	Snezhnogorsk	Sosnovets
Radon	Yasnyi	Snow Dragon	Ivan Papanin
Raychikhinsk	BelomorskLes	Sofiysk	Sosnovets
Rheinstern	Rheinstern	Sofja Perovskaya	Mirnyy
Roschino	Partizansk	Sosnovets	Sosnovets
Rossia	Arktika	Sovetskiy Moryak	Sovetskii Voin
Rubin	Almaz	Sovetskiy Pogranichnik	Sovetskii Voin
Sakhalin-1	Sakhalin-1	Sovetskiy Soyuz	Arktika
Sakhalin-10	Sakhalin-1	Sovietskaya Yakutiya	Sovetskaya Yakutiya
Sakhalin-2	Sakhalin-1	Sovietskiy Voin	Sovetskii Voin
Sakhalin-3	Sakhalin-1	Spartak	Spartak
Sakhalin-4	Sakhalin-1	Spravedlivyy	Stroptivyi
Sakhalin-5	Sakhalin-1	Stakhanovets	Stroptivyi
Sakhalin-6	Sakhalin-1	Stakhanovets Kotov	Stakhanovets Kotov
Sakhalin-7	Sakhalin-1	Stakhanovets Yermolenko	Stakhanovets Kotov
Sakhalin-8	Sakhalin-1	Stepan Krashennikov	Vitus Bering
Sakhalin-9	Sakhalin-1	Stepan Malyghin	Dmitriy Ovtsyn
SakhalinLes	BelomorskLes	Stepan Razin	Dmitry Donskoi
Salavat Yulayev	Spartak	Stepan Savushkin	Krymsk
Saldus	LadogaLes	Stroptivyi	Stroptivyi
Samotlor	Samotlor	SukhonaLes	SukhonaLes
Sasha Borodulin	Pioner	Surgut	Sosnovets
Sasha Kondratyev	Pioner	Suvorovets	Stroptivyi
Sasha Kotov	Pioner	Svetlomor-1	Svetlomor-1
Seapower	Seapower	Svetlomor-3	Svetlomor-1
SelengaLes	BelomorskLes	Svirsk	Povenets
Semyon Dezhnev	Vasilii Pronchishev	Svobodnyi	Partizansk
Sergei Kirov	Sergei Kirov	Tampere	Mirnyy
Sergey Kravkov	Dmitriy Ovtsyn	Tayga	BelomorskLes
Sernovodsk	Sosnovets	Taymyr	Taimyr
Sestroretsk	Sestroretsk	Tebo Olimpia	Tebo Olimpia

SHIP NAME	LISTED UNDER SERIES	SHIP NAME	LISTED UNDER SERIES
Teodor Nette	Pavlin Vinogradov	Vlas Nichkov	Nikolay Novikov
Terney	SibirLes	Vohilaid	Vohilaid
Terry Fox	Terry Fox	VolgoLes	VolgoLes
Thuleland	Thuleland	Volodya Sherbatsevich	Pioner
Tikhon Kiselyov	Kapitan Gavrilov	Voskresensk	BelomorskLes
Tiksi	Norilsk (a.k.a. SA-15)	Vostok-2	Novaya Ladoga (Pr. 596)
Tim Bak	Mikhail Strekalovski	Vyacheslav Denisov	Sovetskii Voin
Tobol	Mirnyy	VyatkaLes	SibirLes
Tolya Bodarchuk	Pioner	Vyborgskaya Storona	Sovetskii Voin
Tolya Komar	Pioner	Vysokogorsk	Igor Ilyinski
Tolya Shumov	Pioner	Vzmorje	SibirLes
Topaz	Almaz	Weserstern	Weserstern
Trans Dania	Trans Dania	World Discoverer	World Discoverer
Turku	Mirnyy	Yakob Kunder	Sovetskii Voin
Tymovsk	Krymsk	Yakov Reznichenko	Sovetskii Voin
Uglegorsk	Uglegorsk	Yakov Smirnitskiy	Dmitriy Ovtsyn
Uikku	Uikku	Yamal	Arktika
Ulan-Ude	BelomorskLes	Yana	SibirLes
Umka	Yasnyi	Yantarnyi	Mirnyy
Ural	Arktika	Yasnyi	Yasnyi
Urengoy	Samotlor	Yekaterina Belashova	Igor Grabar
Urho	Atle	Yelena Shatrova	Igor Ilyinski
Usinsk	Samotlor	Yemeljan Pugachyov	Dmitry Donskoi
Ussuri	Povenets	Yemer	Atle
Ussurijsk	Ventspils	Yeniseysk	Samotlor
Vaga	Mirnyy	Yermak	Yermak
Valentin Shashin	Valentin Shashin	Yerofey Khabarov	Vasilii Pronchischev
Valerian Albanov	Dmitriy Ovtsyn	Yevgeniy Chaplanov	Krymsk
Valeriy Kuzmin	Vitalii Diakonov	Yevgeniy Nikonov	Sovetskii Voin
Valeriy Volkov	Pioner	Yuriy Arshenevskiy	Anatoliy Kolesnichenko
Valya Kotik	Pioner	Yuriy Dolgorukiy	Dmitry Donskoi
Vanino	Vanino	Yuriy Lisianskiy	Vasilii Pronchischev
Vasilii Pronchischev	Vasilii Pronchischev	Yuriy Savinov	Nikolay Novikov
Vasilii Fedoseyev	Kapitan Gotskii	Yuta Bondarovskaya	Pioner
Vasilliy Burkhanov	Anatoliy Kolesnichenko	Yuvent	Ivan Papanin
Vasilliy Golovnin	Vitus Bering	Zabaykalsk	BelomorskLes
Vasilliy Musinskiy	Nikolay Novikov	Zina Portnova	Pioner
Vasya Alekseyev	Novaya Ladoga (Pr. 596)	Zolotitsa	Novaya Ladoga (Pr. 596)
Vasya Korobko	Pioner		
Vaygach	Taimyr		
Velikiy Ustyug	Mirnyy		
Ventspils	Ventspils		
Vera Mukhina	Igor Grabar		
Victor Tkachev	Mikhail Strekalovski		
Viirelaid	Viirelaid		
Viluysk	Samotlor		
Vitaliy Diakonov	Vitalii Diakonov		
Vitus Bering	Vitus Bering		
Vitya Chalenko	Pioner		
Vitya Khomenko	Pioner		
Vitya Sitnitsa	Pioner		
Vladimir Arsenjev	Vitus Bering		
Vladimir Mordvinov	Nikolay Novikov		
Vladimir Sukhotskiy	Dmitriy Ovtsyn		
Vladimir Timofeyev	Nikolay Novikov		
Vladivostok	Moskva		

SHIPS BY SERIES

Alphabetical listing of ships, grouped by the name of the first ship in a series.

SERIES ENTRY LAYOUT

SERIES NAME			SERIES SIZE	ICE CLASS		ICE RANK	
LOA	Bmold	DEPTH	PROP MAC	PROP # / POWER DIS	NOM. SPEED	BOW SHAPE	SHIP TYPES
LBP	Bmax	GROSS	PWR@prop	PROP. TYPE	RANGE	STEM ANGLE	
Dwl	DISPL	DWT	PWR@mach	# OF BLADES / DIAM	FUEL CAP	CREW	
arc	arc	arc	BLRD.THRUST	NOZZLES?	FUEL RATE	THRUSTERS?	
max	max	max	ICEBREAKING CAPABILITY				

(CARGO CAP./HANDLING) (UNLOADING EQUIPMENT) (HELICOPTER AVAILABILITY) (NOTES)

(AUX. ICEBREAKING SYST.)(SERIES MODIFICATIONS) (SPECIAL FEATURES) (REFERENCES)

SHIP ENTRY LAYOUT

SHIP NAME	FORMER NAMES	First?	ICE REG	REG	LLOYD REG#
SHIP OWNER	HOME PORT		FLAG		
SHIPYARD AND YEAR OF CONSTRUCTION	(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)				

EXPLANATION OF CODES

BOW SHAPE CODES

CONC	Conventional wedge with curvilinear line stem and bottom stopper
CONS	Conventional plain wedge with straight-line stem and bottom stopper
CONV	Conventional plain wedge with straight-line stem
SLED	Sledge shaped
SLOP	Sloped plane with wedge
SPOO	Spoon-shaped
THYS	Thyssen-Waas

PROP MACHINERY CODES

DIEL	Diesel-electric
MSDG	Medium-speed Diesel-g geared
NPTE	Nuclear-powered Turbo-electric
SSDG	Slow-speed Diesel-g geared
TUEL	Turbo-electric

SHIP TYPE CODES

ASRV	Antarctic supply research vessel	MSH	Mother ship for submersibles
BULK	Bulk carrier	OTHE	Other type
CGIB	Coast Guard icebreaker	PASS	Passenger
CHEM	Chemical transport	PATR	Patrol boat
CONT	Container carrier	PIB	Polar icebreaker
DRED	Dredge	REFR	Refrigerator
DRIR	Drilling rig	RIB	River icebreaker
DRIS	Drilling ship	RORO	Roll on - Roll off
FERR	Ferry	RV	Research vessel
HLV	Heavy lift vessel	SALV	Salvage tug
IB	Purpose Icebreaker	SUBM	Submersible
LASH	LASH & container carrier	SUPP	Supply ship
MPC	Multi-purpose cargo	SWIB	Shallow-water icebreaker
MPIB	Multi-purpose icebreaker	TANK	Tanker

Akademik Fedorov			1 ships	ULA		rank: 2	
141.20	23.21	13.30	DIEL	1	16.0	CONS	RV
128.60	23.50	13000	14000	FPP	80days	—	SUPP
—	—	—	16500	4 5.1	1900 t.	90	—
—	—	—	—	—	—	Thrusters	—
8.50	10000	7600	1m @ 2kn	—	—	—	—

cranes: 2@50 t. 2@10 t., 2 tractors
for cargo transport on ice.

23x23m. landing pad and 6x6x21
m. hangars for two helicopters Mi-
8 and Ka-32

Hull is coated with low-friction
and anti-fouling coating "Reapox-
LV". Diving station available. Bow
& stern thrusters. 40 double-
occupancy passenger cabins.

Andryushin.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Akademik Fedorov		1987	First	RR		
				Russian Federation		
Rauma-Repola Oy						

Akademik Nalivkin**UL****rank: 3**

81.85	14.83	7.50	—	1	14.5	—
73.50		2833	3090	CPP	12000 n. mi.	—
5.00		1313	—	—	—	31
—			—	Nozzles	—	—

Crew: 31 + 29 scientists

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Akademik Nalivkin			1988		RR		
SoyuzMorGeo		Baku			Azerbaijan		
Schetsyn Shipyard							

Akademik Sergei Vavilov			2	ships	L1	rank: 4
117.10	18.20	10.00	MSDG	2	—	CONV
110.50		6231	—	CPP	—	50
5.90	6600	2275	2570	4	—	128
—			—	—	—	Thrusters

Scientists included in the number of crew.

Bow thruster, azimuthing stern thruster @700kW.

Sheidorov, 1990.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Akademik Ioffe			1989		RR		
Academy of Sciences of Russian Federation		Kaliningrad			Russian Federation		
Hollming Oy-Rauma		Fitted with wind-assisted drive.					
Akademik Sergei Vavilov			1989	First	RR		
Academy of Sciences of Russian Federation		Kaliningrad			Russian Federation		
Hollming Oy-Rauma							

Aleksandr Dovzhenko**5 ships****L1****rank: 4**

100.54	6.80
91.08	14.36
—	—
—	—
5.77	5469
3370	

SSDG	1	13.7	CONV	TIMB
1910	FPP	6000n.mi	—	—
2130	4	—	24	—
—	—	—	—	—

2970 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							

Aleksandr Dovzhenko

1965 First

Aleksandr Kaverznev**IA****rank: 4**

129.65	8.75	SSDG	1	14.3	CONV	CHEM
126.76	19.04	5712	CPP	5500n.mi	45	TANK
6.95	8661	4260	4 4.1		18	
					Thrusters	

11108.4 m^3 total

Bow thruster.

Petrakov.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
<hr/>							
Aleksandr Kaverznev			1981	First	DNV		
Latvian Shipping Co.		Riga					
Oskapshamn							

Alexandr Fadeev			5	ships	L1	rank: 4	
129.40		10.43	SSDG	1	17.5	CONV	CONT
118.19	19.24	6478	4040	FPP	12000n.mi		
—			4490	4		24	
—			—	—	—	—	
7.48	11640	6283					

5624 t., cranes: 1@500 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Aleksandr Fadeyev			1973	First	RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Aleksandr Prokofyev			1975		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Aleksandr Tvardovskiy			1974		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Mikhail Prishvin			1974		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Mikhail Svetlov			1973		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		

Aleksey Kosygin**4 ships****L1****rank: 4**

262.85	32.20	18.30	SSDG	2	17.5	CONS	LASH
232.81		37464	24700	FPP	12000n.mi	36	
—			27200	4 5.6	—	39	
—			—	—	—	—	
11.65	62038	40880					

30340t; cont: 776@20' or 48 lighters
in holds, 704 20' cont. + 34 lighters
18.75x9.5x4.4 m. on deck. Derrick on
the upper deck can lift 500 t. lighters
up to 25.8 m. above inner bottom.

Bow structures, rudder, propeller Bognenko.
and shafting are strengthened to
UL class.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Aleksey Kosygin		1983	First	RR		8227460
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Kherson Shipyard						

Almaz			7 ships		UL		rank: 3	
58.55	12.68	6.02	DIEL	1	13.0	—	SALV	
51.62		1074	1900	—	—	—	TUG	
—			—	4	—	—		
4.61		440	—	—	—	—	Thrusters	
—			—	—	—	—		

Bow thrusters.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Almaz			1976	First	RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskiy			Russian Federation		
Atlas			1987		RR		
Sakhalin Shipping Co.		Korsakov			Russian Federation		
EPRON			1983		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Kapitan Beklemishev			1985		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Lazurit			1990		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivistok			Republic of China		
Rubin			1982		RR		
Sakhalin Shipping Co.		Korsakov			Russian Federation		
Topaz			1984		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		

Almirante Irizar**1 ships****rank: 1**

119.30		DIEL	2	18.5	CONC	CGIB
—	25.00	11910	FPP	—	22	
9.50	11810	14350	4	—	133	
—		138	—	—	—	
—	14900					

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Almirante Irizar

1978 First

Argentina

Kvaerner Masa-Yards

Anatoliy Kolesnichenko			5 ships		ULA		rank: 2	
173.50	24.50	15.20	MSDG	1	17.0	CONS	BULK	
164.90	24.54	18574	13600	CPP	12000n.mi	30	MPC	
8.50	24100	12450	15400	4 5.6	—	44	RORO	
9.00	25900	14250	160	—	—	—		
10.50	31200	19550	1.0m.@2 kn.					

12200 t., cont: 576@20'(40'), incl. 50
refr., cranes: 5

This series is a modification of the
"Norilsk" Series. Modifications
include: further strengthening of
stem and bow bottom and stern
plating, and increasing of
deadweight and cargo capacity.

Semenov.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Anatoliy Kolesnichenko			1985	First	RR		8406688
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Valmet Oy Helsingin Telakka							
Kapitan Danilkin			1987		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Kapitan Mann			1985		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Vasilliy Burkhanov			1986		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Yuriy Arshenevskiy			1986		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		

Anna Akhmatova		
88.00	17.20	7.40
78.00	17.20	4575
—	—	—
—	—	—

UL

rank: 3

—	1	14.0	—
—	—	2000	—
3200	—	—	22
—	—	208 g/kW-hr	—
—	—	—	—
750 t., 150 pass. + 90 seats			

Bow & stern thrusters.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Anna Akhmatova		1988		RR		
Ministry of Gas Industry of the Russian Federation				Russian Federation		
Stocznia im. Komuny Pariskiej Gdynia						

Anna Karenina			1	ships	L1	rank: 4
145.19	25.20	13.29	—	2	17.5	FERR
131.27	25.51	14213	19124	CPP	—	PASS
5.29		2830	—	—	—	RORO
—			—	—	—	

425 cars, 54 trucks. Bow door &
ramp 11.3x8.0, stern door & ramp
11.2x10.60.

2 bow thrusters.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Anna Karenina	Baltika, Viking Song	1980	First	RR		
Rigorous Shipping Co. Ltd.	Limassol			Cyprus		
Wartsilla Shipyards						

Aranda		
—	13.60	6.70
59.00	13.80	1734
4.60	1800	
—		

IA Super

rank: 3

SSDG	1	—	—	RV
—	CPP	—	—	
3000	4	—	12	
—	Nozzles	—	—	

Hangar & elevator for 2
helicopters.

Room for researach team of
25

Bow & stern thrusters @400 kW
& 150 kW.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Aranda		1989	First	FR		8802076
Finnish Board of Navigation	Helsinki			Finland		
Wartsilla Shipyards						

Arctic			1 ships		2		rank: 2	
220.85	22.86	15.20	MSDG	1	16.5	CONC	BULK	
206.20	22.90	20117	8800	CPP	—	30	TANK	
10.50		26440	10800	4 5.2	—	46		
			155	Nozzles	—	—		
11.07	38466	28400	1.0 @ 2kn					

cranes: 4@20 t., 5 pumps

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Arctic		1978	First	CR	LR	7517507
The Royal Trust Co.	Ottawa			Canada		
Port Weller Dry Docks Ltd.						

Arctic Tuktu**A****rank: 3**

11.58	4.57	—	—	—	—	SUPP
48.67	719	—	—	—	—	
4.06		2350	4	—	—	
—		—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		HOME PORT		FLAG		
SHIPYARD		(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)		(CHARTER RATE AND OP. COSTS)				

Arctic Tuktu	Mary B.		1972	ABS		7207310
Star Shipyard Ltd.		Edmonton		U.S.A.		

Arcticshelf**UL****rank: 4**

—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		HOME PORT		FLAG		
SHIPYARD		(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)		(CHARTER RATE AND OP. COSTS)				

Arcticshelf**Nauka**

Equipped for drilling in deep sea up to 5000 m.
depth.

Arktika			6 ships			LL1		rank: 1	
148.00	28.00	17.20	NPTE	3	1:1:1	20.8	CONS	IB	
136.00	30.00	18172	49000	FPP		Unlimited	24		
11.00	23460		55100	4	5.3	—	145		
—			480	—		—	—		
		4096	2.25m @ ~2kn						

cranes: 2@3 t.

"Ural", the sixth ship in a series is under construction, to be commissioned in 1995.

Tsoy (1992); Tsoy (1993); Tsoy (1990); Wind.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Arktika	Leonid Brezhnev	Murmansk	1974	First	RR		7429061
Murmansk Shipping Co.					Russian Federation		
Admiralty Ship Yard					Sixth ship in a series is under construction as of 4/94.		
Rossia		Murmansk	1985		RR		
Murmansk Shipping Co.					Russian Federation		
Admiralty Ship Yard							
Sibir		Murmansk	1977		RR		
Murmansk Shipping Co.					Russian Federation		
Admiralty Ship Yard							
Sovetskiy Soyuz		Murmansk	1989		RR		
Murmansk Shipping Co.					Russian Federation		
Admiralty Ship Yard							
Ural							
					Russian Federation		
Admiralty Ship Yard							
Yamal		Murmansk	1992		RR		
Murmansk Shipping Co.					Russian Federation		
Admiralty Ship Yard							

Atle			5 ships			rank: 1	
104.60		12.10	DIEL	4	18.0	CONS	IB
96.00	23.80	6844	16170	FPP	—	20	
7.30	8000		18380	4	—	54	
—			191	—	—	—	
8.30	9500		1.1m @ 2kn				

props: 2 aft & 2 fore
Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Atle			1974	First			7347627
The National Maritime Administration of Sweden		Norrkoping			Sweden		
Wartsilla Shipyards							
Frej			1975				
					Sweden		
Wartsilla Shipyards							
Sisu			1976				
					Finland		
Wartsilla Shipyards							
Urho			1975	First	DNV	FR	7347615
Finnish Board of Navigation		Helsinki			Finland		
Oy Wartsila Ab							
Yemer			1977				
					Sweden		
Wartsilla Shipyards							

Aurora Austrelis			1	ships	2	rank: 3	
94.90	20.30	13.25	MSDG	1	13.0	IB	
88.40		6574	10000	CPP	24000 m. mi.	RV	
7.85		3500	—	—	—	24	SUPP
—			—	—	—	—	
			1.2 m. @2.5 kn.				

1600 m³., tanks 1000 m³.

Hangar for 2 Seahawk helicopters.

Crew of 29 +109. Bow and stern are strengthened to CASPPR ice class 3.

Double-hull design.

Bow thrusters @800kW. 2 retractable, azimuthing stern thrusters @400 kW each.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Aurora Austrelis				CR	LR	
Antarctic Shipping Pty. Ltd.	Hobart, Tas.			Austrelia		

Balkhash			3	ships	L1	rank: 4	
72.15		5.00	MSDG	1	11.5	CONV	TIMB
65.40	11.32	1124	660	FPP	3000n.mi		
—			735	4	—	21	
—			—	—	—	—	
4.35	2257	1367					

1210t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Bakhchisaray			1971		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Balkhash			1969	First	RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Belomorye			1970		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		

Baltic Press	2	ships	IA	rank: 4
135.85 16.50 10.90	—	—	13.5	CONT
128.35 16.79 1366	—	—	—	RORO
4.45 4450	2647	4	—	—
—	—	—	—	—
4.60	—	—	—	—

cont: 249@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Baltic Press		0		ABS		7802067
Ture TA Axelsson	Skarhamn			Sweden		
Baltic Print				ABS		7902861
Ture TA Axelsson	Skarhamn					
Karliskronavarvet A/B						

BelomorskLes			29 ships		L1		rank: 4	
123.88	16.70	8.45	SSDG	1	16.0	CONV	TIMB	
115.00		4519	3600	FPP	6000n.mi			
—			4010	4	—	25		
—			—	—	—	—		
6.82	9220	5726						

4973 t., cranes: 1@40 t. 1@15 t. 8
@10 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
AltayLes			1963		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Baykonur			1967		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
BelomorskLes			1962	First	RR		5040122
Northern Shipping Company		Arkhangelsk			Russian Federation		
Stocznia Gdanska im. Lenina							
Darasun			1967		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Dzhurma			1968		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Elektrostal'			1966		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kansk			1967		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Khatanga			1968		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Kholmsk			1965		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Mekhanik Rybachuk			1963		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Orekhovo-Zuyevo			1966		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		

Pobedino Sakhalin Shipping Co.	Kholmsk	1967	RR Russian Federation
Poronin Sakhalin Shipping Co.	Kholmsk	1967	RR Russian Federation
Raychikhinsk Sakhalin Shipping Co.	Kholmsk	1967	RR Russian Federation
SakhalinLes Sakhalin Shipping Co.	Kholmsk	1963	RR Russian Federation
SelengaLes Northern Shipping Company	Arkhangelsk	1963	RR Russian Federation
Shadrinsk Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1967	RR Russian Federation
Shatura Sakhalin Shipping Co.	Kholmsk	1966	RR Russian Federation
Tayga Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii	1964	RR Russian Federation
Ulan-Ude Sakhalin Shipping Co.	Kholmsk	1968	RR Russian Federation
Voskresensk Sakhalin Shipping Co.	Kholmsk	1966	RR Russian Federation
Zabaykalsk Sakhalin Shipping Co.	Kholmsk	1967	RR Russian Federation

Canmar Explorer			2 ships	IAA	rank: 3
—	30.48	8.71	—	10.0	DRIS
109.19		6041	—	—	
6.76	12445	6419	2206	4	
—			—	—	

cranes: 1@80 t. 1@35 t. 1@30 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Canmar Explorer	Snakehead ('76)	1945		ABS		4507870
Canadian Marine Drilling	Halifax, N.S.			U.S.A.		
Southeastern SB Corp.	Widened by addition of sponsons 130'x15'x26.37', installed by Purvis Navcon Shipyard Ltd., Canada, 1980.					
Canmar Explorer II	Mooring Hitch ('76)	1945		ABS		4505915
Canadian Marine Drilling	Halifax, N.S.			U.S.A.		
J. A. Jones Construction Co. Inc.	Widened by addition of sponsons 130'x15'x26.37', installed by Purvis Navcon Shipyard Ltd., Canada, 1980.					

Canmar Kigiriak			1	ships	4	rank: 1	
91.00	17.85	10.04	SSDG	1	18.8	SPOO	IB
78.90	19.31	3642	12800	CPP	—	24	SUPP
—	7806	2066	—	4 5.1	—	—	TUG
8.50	8550	—	162	Nozzles	—	—	—
			1.5 m.@3kn				

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Canmar Kigiriak		1970	First	CR		7305280
Amoco Canada Research Ltd.	Vancouver, BC.			Canada		
St. John SB & Dry Dock Co.						

Discoverer 534		
162.69	24.38	9.75
148.14	24.49	12011
7.35	20562	7286
—	—	—

		IA	rank: 4
—	—	10.0	DRIS
11765	—	—	—
16047	4	—	—
—	—	—	—

cranes: 2@42 t. 2@3 t.

Bow and stern thrusters added

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Discoverer 534				ABS		7509378
	Panama			Panama		
Mitsui SB & Engineering Co.,Ltd.	Bow and stern thrusters added					
Discoverer Seven Seas				ABS		7611561
Deep Ocean Drilling Inc.	Panama			Panama		
Mitsui SB & Engineering Co.,Ltd.						

Discovery		
—	12.80	5.79
—	74.93	2038
—	5.06	
—		

IA				rank: 4
—	—	—	—	RV
—	—	—	—	
—	4	—	—	
—	—	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Discovery				ABS		7406475
	Panama					
Burrard Dry Dock Co.Ltd.						

Dmitriy Ovtsyn			13 ships		UL	rank: 3	
66.83	11.87	6.02	SSDG		13.8	CONV	RV
60.00	11.92	1134	1618	FPP			
				4			
4.12		639	13				

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Dmitriy Ovtsyn		1970	First	RR		7019074
Oy Laivateollisuus Ab				Russian Federation		
Dmitriy Sterlegov		1971		RR		
Tiksi Hydrography				Russian Federation		
Eduard Toll		1972		RR		
Tiksi Hydrography				Russian Federation		
Fyodor Matisen		1976		RR		
Providenie Hydrography				Russian Federation		
Ivan Kireyev		1977		RR		
Arkhangelsk Hydrography				Russian Federation		
Nikolay Kolomeytsev		1972		RR		
Arkhangelsk Hydrography				Russian Federation		
Nikolay Yevghenov		1972		RR		
Igarka Hydrography				Russian Federation		
Pavel Bashmakov		1977		RR		
Arkhangelsk Hydrography				Russian Federation		
Serghey Kravkov		1974		RR		
Arkhangelsk Hydrography				Russian Federation		
Stepan Malyghin		1971		RR		
Providenie Hydrography				Russian Federation		
Valerian Albanov		1977		RR		
Arkhangelsk Hydrography				Russian Federation		

Vladimir Sukhotskiy Tiksi Hydrography	1973	RR Russian Federation
Yakov Smirnitskiy Arkhangelsk Hydrography	1977	RR Russian Federation

Dmitry Donskoi			13 ships		UL		rank: 3	
162.10	22.86	13.50	SSDG	1	15.2	CONV	BULK	
154.88	22.92	13567	7430	FPP	6000n.mi			
9.02		19590	8240	4	---	25		
9.88	27340	19885	---	---	---	---		

18737 t., 22257 m³, cont: 442@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Admiral Ushakov			1979		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Aleksandr Nevskiy			1978		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Aleksandr Suvorov			1979		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Dmitriy Pozharskiy			1978		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Dmitry Donskoi			1977	First	RR		7721196
Murmansk Shipping Co.		Murmansk			Russian Federation		
Ivan Bogun			1981		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Ivan Susanin			1981		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Kuzma Minin			1980		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Mikhail Kutuzov			1979		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Pyotr Velikiy			1978		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							
Stepan Razin			1980		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
VEB Warnemuende							

Yemeljan Pugachyov Murmansk Shipping Co. VEB Warnemuende	Murmansk	1980	RR Russian Federation
Yuriy Dolgorukiy Murmansk Shipping Co. VEB Warnemuende	Murmansk	1980	RR Russian Federation

Drogobych (Ocean A/B)		
116.08	16.30	7.83
106.00		4198
6.67		5780
—		

UL				rank: 3
MSDG	—	13.0	—	TANK
—	—	—	—	
2574	—	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
<hr/>							
Drogobych	Ocean A, Ocean B		1972				
SICO Ltd.		Kingston				The Grenadines	
<hr/>							
Kapitan Djachuk			1975		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Georgi Dimitrov Shipyard							
<hr/>							
Kapitan Dotsenko			1975		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
<hr/>							
Kapitan Kobets			1976		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
<hr/>							
Kapitan Nevezhkin			1976		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
<hr/>							
Kapitan Shevtsov			1973		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		

Dunker		
	10.00	5.30
30.00		
—		
—		
—		
4.70		

IA

rank: 4

MSDG	—	12.5	—	TUG
2680	—	—	—	
—	—	—	—	
39	—	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		HOME PORT		FLAG		
SHIPYARD		(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)		(CHARTER RATE AND OP. COSTS)				

Dunker

LR

Emsstern			2 ships		E3		rank: 4	
110.00	17.70	10.60	SSDG	1	12.5	CONV		
124.00		6262	3600	CPP	5000 mi.	45		
8.54		10650	—	— 3.1	—	19		
—			—	—	—	—		

10000 m³.

Double-hull design.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Elbestern			1992	First	GL		
Rigel Schiffahrts					Germany		
MTW Schiffbau Werft							
Emsstern			1992	First	GL		
Rigel Schiffahrts					Germany		
MTW Schiffbau Werft							

Fastov	2	ships	L1	rank: 4
121.82 17.59 9.91	—	—	15.0	CONV MPC
113.44 17.61 5583	—	—	—	—
—	3972	4	—	—
— 7810	—	—	—	—
—	—	—	—	—
7.72				

cont: 258@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Fastov	Gaviota ('85), Gaviota II ('83)	1979	First	RR		7932692
Murmansk Shipping Co.	Murmansk			Russian Federation		
Veb Shiftswerft Neptun						
Konstantinovka		1981		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		

Fennica			2 ships		Polar-10		rank: 2	
116.00	26.00	12.50	DIEL	2	16.0	SPOO	IB	
—			15000	APD	—	—	SUPP	
7.00	4800	1650	21000	4 4.2	—	—	SWIB	
8.00		3900	234	Nozzles	—	Thrusters		
8.40		4800	0.8 m.@8 kn, 1.8 m.@2 kn.					

cranes: 1 @120 t. @8.2 m., 1 @15 t. @14 m. 1 @5 t. @30 m.

Helicopter, hangar & elevator available

A second ship in the series is to be commissioned in 1995

3 bow thrusters at 1150 kW

SW&S, SW&S-a; SW&S-b; Thompson.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Fennica			1993	First	DNV		
Rauma-Repola Oy					Finland		

Finnfellow**IA Super****rank: 3**

137.37	24.54	17.35
126.40	24.69	8304
6.12		4995
—		

—	2	19.3	—	PASS
—	CPP	—	—	RORO
10300	—	740 t.	—	
8240	—	—	—	Thrusters

26 rail wagons, 55 trailers, 170 cars.

Stern door/ramp, side door/ramp.

Bow thruster.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Finnfellow		1973	First	FR		7214002
Laivanisannistoyhtio Raiifellow	Helsinki			Finland		
Wartsilla Shipyards						
Finnmaid	Hans Gutzeit, Capella	1972		FR		
Laivanisannistoyhtio Raiifellow	Helsinki			Finland		
Wartsilla Shipyards						

Finnfighter		
159.16	20.01	12.63
151.62	21.42	
6.87		
9.15		

IA Super

rank: 3

	1			MPC
7280	CPP			

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Finnfighter	Kaipola		First			
		Nassau		Bahamas		
Wartsilla Shipyards						

Finnmerchant**IA Super****rank: 3**

155.00	24.96	16.92
146.01	25.15	
8.47		
—		

—	1	18.5		
13200	CPP		—	RORO
—	—	—	—	
—	—	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Finnmerchant

First LR

Helsinki

Rauma-Repola Oy

Frontier Spirit**IA Super****rank: 3**

111.50	17.00	11.90	MSDG	2	16.9	CONS	PASS
98.00	17.25	6752	4120	CPP	—	30	RV
—	—	—	4860	—	—	80	—
4.55	—	1226	—	—	—	—	—
—	—	—	—	—	—	—	—

second sister-ship is to be
commissioned in late 1994

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Frontier Spirit		1991		DNV		
Frontier Croises Ltd.	Nassau			Bahamas		
Mitsubishi Heavy Industries						

Gerakl			1	ships	L1	rank: 4
72.50	13.20	7.19	—	—	17.0	SALV
65.00	13.64	1655	—	—	—	TUG
—	—	—	—	—	—	
—	—	—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Gerakl		1974	First	RR		7336587
Baltic Shipping Co.	St. Petersburg			Russian Federation		

Glomar Beaufort Sea I		
—	89.91	30.48
—	95.24	11339
—	21.03	
—		

IAA

rank: 3

—	—	—	—	DRIR
—	—	—	—	
—	—	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		HOME PORT		FLAG		
SHIPYARD		(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)		(CHARTER RATE AND OP. COSTS)				

Glomar Beaufort Sea I				ABS		8402000
	Houston					
Nippon Kokan K.K.Tsu Shipyard						

Henry Larsen			1	ships	4	rank: 1		
100.03	19.51		DIEL	2	15.5		IB	
87.95	19.82	6166		CPP	15000 n. mi.	—		
7.20	8290	2478	17760	4	—	—		
—			—	—	—	—		

Hangar for 1 helicopter.

Air bubbling system.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Henry Larsen		1988	First	CR	LR	8409329
Transport Canada (Gov't of Canada)	Ottawa			Canada		
Versatile Pacific Shipyards Inc.						

Highland Sentinel			IA			rank: 4		
—	12.80	5.80	—	2	15.0	—	SUPP	—
60.39		919	—	CPP	—	—		—
4.77			5176	4	—	—		—
—			—	—	—	—		—

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Highland Sentinel			1974		ABS		7421788
Gulf Offshore N.S. Ltd.		Panama			Panama		
Teraoka SB Co.Ltd.							

IgarkaLes			9	ships	L1	rank: 4	
102.30	14.00	7.04	SSDG	1	13.6	CONV	TIMB
93.28		2730	1910	FPP	6630n.mi		
—			2130	4	—	24	
—			—	—	—	—	
5.92	5542	3629					

3250 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
<hr/>						
IgarkaLes		1962	First	RR	Russian Federation	
<hr/>						
IrtysLes		1963		RR		5424263
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Valmet Oy Helsingin Telakka						
<hr/>						
Istra		1964		RR		6405501
Northern Shipping Company	Arkhangelsk			Russian Federation		
Valmet Oy Helsingin Telakka						
<hr/>						
IzhmaLes		1962		RR		5166158
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Valmet Oy Helsingin Telakka						
<hr/>						
IzhoraLes		1963		RR		5166160
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Valmet Oy Helsingin Telakka						
<hr/>						
KamaLes		1964		RR		6418364
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Hollming Oy-Rauma						

Igor Grabar			6 ships		UL		rank: 3	
97.32	16.00	7.70	SSDG	1	13.2	CONV	BULK	
90.08	16.24	3184	2570	FPP	6000n.mi	—	TIMB	
—	—	—	2830	4	—	23	—	
—	—	—	—	—	—	—	—	
6.36	6535	4054	—	—	—	—	—	

3580 t., cranes: 1@35 t. 1@20 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Igor Grabar		Arkhangelsk	1973	First	RR		7231086
Northern Shipping Company					Russian Federation		
Hollming Oy-Rauma							
Ivan Shadr		Arkhangelsk	1973		RR		
Northern Shipping Company					Russian Federation		
Konstantin Yuon		Arkhangelsk	1973		RR		
Northern Shipping Company					Russian Federation		
Mikhail Cheremnykh		Arkhangelsk	1973		RR		
Northern Shipping Company					Russian Federation		
Vera Mukhina		Arkhangelsk	1973		RR		
Northern Shipping Company					Russian Federation		
Yekaterina Belashova		Arkhangelsk	1973		RR		
Northern Shipping Company					Russian Federation		

Igor Ilyinski			8 ships		UL		rank: 3	
132.70		8.80	SSDG	1	15.2		CONV	TIMB
122.00	19.86	7120	4335	CPP	7300n.mi			
6.88	11754	8256	5100	4			21	

6508 t., cont: 318@20', cranes:
4@20'

Low-friction, abrasion-resistant
coating "Inerta 160"

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Abakan			1990		RR		
Karmi ltd.		Vladivostok			Russian Federation		
Ast. Reunidos del Nervion S.A.							
Igor Ilyinski			1990	First	RR		8711253
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Ast. Reunidos del Nervion S.A.							
Vysokogorsk			1991		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Ast. Reunidos del Nervion S.A.							
Yelena Shatrova			1990		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Ast. Reunidos del Nervion S.A.							

Ikaluk			2 ships		4	rank: 1	
78.95		9.71	MSDG	2	12.0	—	IB
70.00	17.22	3256	—	CPP	—	—	SUPP
—			11000	4	—	19	TUG
8.11	5107	1900	—	—	—	—	—
7.53			150	—	20 m^3/day *	Thrusters	—
—			—	—	—	—	—

* Fuel consumption rate in ice:
35-60 m³/day.

Bow and stern thrusters, water
jet lubrication system.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Ikaluk			1983		CR	LR	8130693
Canadian Marine Drilling		Vancouver			Canada		
Nippon Kokan K.K.Tsu Shipyard							
Miscaroo			1983		CR	LR	8127830
Canadian Marine Drilling					Canada		
Nippon Kokan K.K.Tsu Shipyard							

Илич			1 ships		L1	rank: 4	
128.02	22.00	13.52	MSDG	2	22.0		FERR
115.80		12281		CPP			PASS
			13240		681 t.		RORO
5.42						Thrusters	

Bow door, stern door.

Bow thruster.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Ilyich	Stena Baltica	1973	First	RR		7224459
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Wartsilla Shipyards						

Ivan Papanin			3 ships	ULA	rank: 2	
167.00	22.30	13.50	SSDG	1	16.7	ASRV
147.20	22.60	14184	28200	CPP	8000 n.mi.	RORO
8.00	18090	7600	29400	4	39	SUPP
9.00	21000	10500		Nozzles		
9.00	21000	10500				
			1.1m.@1.5kn			

8900 t., 14400 m³, cont: 329@20',
cranes: 6@25 t. Can handle oversize
(7x24 m.) & heavy (80 t.) units.

Room for 10 passengers and
helicopter crew of 6

low-friction, abrasion-resistant
coating. The ships in this series
can serve as Antarctic Supply
Vessels with range up to 14000
n. mi. (at a cost in deadweight).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Ivan Papanin			1990	First	RR		8837928
Murmansk Shipping Co.		Murmansk			Russian Federation		
Kherson Shipyard							
Snow Dragon			1990				
					Republic of China		
Yuvent			1992				
Aqua Ltd. Shipping							
Kherson Shipyard							

Jaguar			L1		rank: 4
92.79	15.63	7.70	SSDG	18.8	SALV
80.40		2781	—	—	TUG
5.90			—	—	—
—			—	—	Thrusters

Bow Thrusters.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Bars		1977		RR		7729837
Far Eastern Basin Administration	Vladivostok			Russian Federation		
Admiralty Ship Yard						

James Clark Ross			IA Super			rank: 3
99.04	18.85	9.80	DIEL	—	15.5	RV
90.00	18.89	5732	6250	—	—	SUPP
6.50	7400	2500	6650	—	1200 t.	—
—	—	—	65	—	—	—
—	2917	—	1 m.@2 kn.	—	—	—

A-boom: 1@30 t.

Bow & stern jet pumps

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
James Clark Ross		1991		LR		8904496
	Port Stanley, Falkland Isl.			Great Britain		

Kapitan Belousov**3 ships****LL4****rank: 2**

83.17	18.70	9.50
77.12	19.41	3710
6.20	4500	
7.00	5350	

DIEL	4	1:1+0.5:0.5	16.5	CONS	IB
7700	FPP		28days	22	
8827	4	3.5		85	
—	—	—	—	—	—
1m@2kn					

2 aft & 2 fore prop.

Tsoy (1992).

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kapitan Belousov		1954	First	RR		5181598
Azov Shipping Co.	Mariupol			Ukraine		
Wartsilla Shipyards						
Kapitan Malakhov		1955		RR		
Wartsilla Shipyards						
Kapitan Voronin		1955		RR		
Wartsilla Shipyards						

Kapitan Chechkin		6 ships		LL4		rank: 2	
16.30	DIEL	3	1:1:1	14.0			RIB
76.50 16.60		CPP					
2.50 2240	3300	4					
3.30	59						

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							

Kapitan Bukaev RR
Russian Federation

Wartsilla Shipyards

Kapitan Chadaev 1978 RR
Russian Federation

Wartsilla Shipyards

Kapitan Chechkin 1977 First RR
Russian Federation

Wartsilla Shipyards

Kapitan Krutov 1978 RR
Russian Federation

Wartsilla Shipyards

Kapitan Plakhin 1977 RR
Russian Federation

Wartsilla Shipyards

Kapitan Zarubin 1978 RR
Russian Federation

Wartsilla Shipyards

Kapitan Gavrilov			10 ships		L1		rank: 4	
203.06	25.40	15.90	SSDG	1	20.0	CONV	CONT	
192.73	25.46	21584	15880	FPP	21000n.mi			
			15660	4		27		
9.82	25050	16030						

11810 t., cont: 1254@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kapitan Gavrilov		1982	First	RR		8201624
Baltic Shipping Co.	St. Peterburg			Russian Federation		
VEB Warnemuende						
Kapitan Kanevskiy		1982		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Kapitan Kozlovskiy		1982		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Nikolay Tikhonov		1983		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Professor Tovstyk		1985		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Tikhon Kiselyov		1984		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		

Kapitan Goncharov			3 ships	UL	rank: 3		
131.60	19.30	8.80	SSDG	1	15.0	CONV	MPC
122.00		6395		FPP	6500n.mi		
			4690	4		30	
7.00	11170	7700					
		7000					

6130 t., cont: 272@20', grain: 9660
m^3, cranes: 2@12.5 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kapitan Chmutov			1991		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Malta SB. Co. Ltd							
Kapitan Goncharov			1989	First	RR		8502042
Baltic Shipping Co.		St. Peterburg			Russian Federation		
Malta SB. Co. Ltd							
Kapitan Primak			1990		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Malta SB. Co. Ltd							

Kapitan Gotskii			6 ships	ULA	rank: 2	
133.00	18.50	11.60	DIEL	1	15.0	MPC
118.40	18.80	7684	4760	FPP	8000n.mi.	29
7.60	11290	6280	5300	4	—	55
—	—	—	—	—	—	—
8.90	13840	8723	0.7 m. @ 2kn			

5000 t., cranes: 2@60 t. 2@10 t.
6@5 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kapitan Gotskii	Amguema		1965	First	RR		6822694
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Leninskogo Komsomola							
Kapitan Kondratjev			1972		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Leninskogo Komsomola							
Kapitan Myshevskiy			1970		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Leninskogo Komsomola							
Navarin			1967		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Leninskogo Komsomola							
Pavel Ponomaryov			1971		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Leninskogo Komsomola							
Vasiliy Fedoseyev			1969		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Leninskogo Komsomola							

Kapitan Lus		
98.20	7.80	
89.40	17.60	
—		
—		
6.70	4670	

1A

rank: 4

—	1	12.5	CONV	BULK
—	—	5000 n. mi.	40	CONT
3360	—	—	22	TIMB
—	—	—	—	

5654 m³ in 3 holds, double-hull,
4125 t., cont: 241, cranes: 2@8
t.@22m.

Vinogradov.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kapitan Lus		1993		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Vyborg Shipyard						

Kapitan M. Izmailov			3 ships		LL4		rank: 2	
56.50	15.60	6.00	DIEL	2	14.0		RIB	
52.20	16.00		2500	FPP	15days	25		
4.20	2050		3940	4		24		
—			—	—	—	—		
			0.6 m. @3 kn.					

Tsoy (1992).

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kapitan A. Radjabov		1976		RR		
Wartsilla Shipyards	Baku			Azerbaijan		
Kapitan Kosolapov		1976		RR		
Wartsilla Shipyards				Russian Federation		
Kapitan M. Izmailov		1976	First	RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Wartsilla Shipyards						

Kapitan Panfilov			11 ships		L1		rank: 4	
146.10		12.89	SSDG	1	14.0	CONV	BULK	
134.40	20.59	10145	4490	FPP	6000n.mi			
			4930	4		26		
9.42	20165	14632						

13742 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kapitan Panfilov			1975	First	RR		

Kapitan Sakharov			5	ships	UL			rank: 3
130.00	17.00	8.50	SSDG	1	15.0	CONV	CONT	
119.00	17.30	4827	4440	FPP	6500n.mi			
—			4930	4	—	31		
—			—	—	—	—		
6.92	17150	5780						

4410 t., cont: 320@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kapitan Gnezdilov			1980		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok				Russian Federation		
Kapitan Krems			1980		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok				Russian Federation		
Kapitan Sakharov			1979	First	RR		7831757
Northern Shipping Company	Arkhangelsk				Russian Federation		
Vyborg Shipyard							
Kapitan Sergiyevskiy			1981		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok				Russian Federation		
Kapitan Zheltovskiy			1980		RR		
Northern Shipping Company	Archangelsk				Russian Federation		

Kapitan Sorokin			4 ships		LL3	rank: 1	
141.40	12.30		DIEL	3	1:1:1	18.5	IB
130.20	30.50	10609	16200	FPP		28days	12
8.50	17270		18100	4			83
—			181	—			—
			2.25 m.				

Petrakov; Simonov; Tsoy
(1993); Tsoy (1992); Tsoy
(1990); SW&S (1992).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kapitan Dranitsyn			1980		RF		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Kapitan Khlebnikov			1981		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kapitan Nikolayev			1978		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
		1991, Kvaerner Masa Yards modified as follows: Sledge-shaped bow installed. Dimensions changed: LBP=132.00 m., Displ=17270 t., Speed=18 kn., ice capability=1.9 m.					
Kapitan Sorokin			1977	First	RR		7413488
Murmansk Shipping Co.		Murmansk			Russian Federation		
Oy Wartsila Ab		Moderniz. made by "Thyssen Nordseewerk". Original bow replaced by Tyssen-WAAS bow shape. Dimensions changed as follows: LOA=141.44 m.; LPB=132.39 m., Breadth=30.50 m., Displ.=17150 t., Speed=18.5 kn., Ice capability=1.8 m.					

Kapitan Yevdokimov	8	ships	LL4	rank: 2
71.20 16.60 4.60	DIEL	4	13.5	RIB
76.50	3794	FPP	25	
2.50 2150	4809	4		

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kapitan Babichev		1983		RR		
Kvaerner Masa-Yards				Russian Federation		
Kapitan Borodkin		1983		RR		
Kvaerner Masa-Yards				Russian Federation		
Kapitan Chudinov		1983		RR		
Kvaerner Masa-Yards				Russian Federation		
Kapitan Demidov		1984		RR		
Kvaerner Masa-Yards				Russian Federation		
Kapitan Mecaik		1984		RR		
Kvaerner Masa-Yards				Russian Federation		
Kapitan Moshkin		1986		RR		
Kvaerner Masa-Yards				Russian Federation		
Kapitan Yevdokimov		1983	First	RR		
Kvaerner Masa-Yards						
Kapitan Zavenyagin		1984		RR		
Kvaerner Masa-Yards				Russian Federation		

Katmai Bay		
—	11.28	3.66
42.68		500
—		
—		
—		

rank: 3

—	—	—	—	IB
—	—	—	—	TUG
—	—	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							

Katmai Bay			1978		ABS		
US Coast Guard		Washington			U.S.A.		
Tacoma Boatbuilding Company Inc.							

Kiisla**IA****rank: 4**

17.60	MSDG	1	14.0			TANK
105.20		CPP				
6.60	3700	4				

pumps: 12

air bubbling system installed. Double-skin hull.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kiisla			1973	First	FR		7347500
Neste Oy		Naantali/Nadendal			Finland		
Valmet Oy Helsingin Telakka							

Komandor			4 ships	L1	rank: 4		
88.30	13.60	6.60	—	1	19.2	—	PATR
82.20	13.60	2800	—	CPP	7000 n. mi.	—	SALV
—			56704	—	—	42	
4.70		534	—	—	—	—	
—			—	—	—	—	

Hangar for 1 helicopter Ka32C

Active side rudders make it possible for helicopter to land and take off in 8.5 m. waves (sea state 7 on Beaufort Scale).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Komandor			1989		RR		
					Russian Federation		
Danyard							

Kosmonavt Pavel Beliyev**L1****rank: 4**

123.15	16.69	10.80	—	—	14.8	—	CONV	RV
113.00	16.74	5473	—	—	—	—	—	—
—	—	2460	3825	4	—	—	—	—
—	—	—	—	—	—	—	—	—
6.71	—	—	—	—	—	—	—	—

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kosmonavt Pavel Beliyev	Vyegrales-74		1969	First			5409732
Baltic Shipping Co.		St. Peterburg			Russian Federation		
Zhdanov Shipyards							
Kosmonavt V. Patsayev			1968		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Kosmonavt V. Volkov			1964		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		

KotlasLes			15 ships		L1		rank: 4	
102.10	14.00	6.85	SSDG	1	13.6	CONV	TIMB	
93.00		2924	1910	FPP	8500n.mi			
—			2130	4	—	24		
—			—	—	—	—		
5.70	5335	3480						

3082 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
KotlasLes		1962	First		Russian Federation	

Krymsk			21 ships	L1	rank: 4	
104.50	7.10		SSDG	1	13.5	CONV
94.50	14.36	3019	1910	FPP	6000n.mi	TIMB
			2130	4		24
6.05	6000	3860				

3440 t.

SISTER SHIPS

SHIP NAME SHIP OWNER SHIPYARD (SPECIAL FEATURES)	FORMER NAMES	HOME PORT (MODERNIZATION) (CHARTER RATE AND OP. COSTS)	YR BUILT	First?	ICE RE FLAG (NOTES)	REG	LLOYD REG#
Anton Buyukly Sakhalin Shipping Co.		Kholmsk	1969		RR Russian Federation		
Boris Nikolaychuk Sakhalin Shipping Co.		Kholmsk	1969		RR Russian Federation		
Karaga Far-Eastern Shipping Co. / Vladivostok		Vladivostok	1970		RR Russian Federation		
Katangli Sakhalin Shipping Co.		Kholmsk	1968		RR Russian Federation		
Kavalerovo Far-Eastern Shipping Co. / Vladivostok		Vladivostok	1970		RR Russian Federation		
Kirensk VietSovLikhter			1968		RR Russian Federation		
Krasnopolye Sakhalin Shipping Co.		Kholmsk	1968		RR Russian Federation		
Krasnoturjinsk Sakhalin Shipping Co.		Kholmsk	1968		RR Russian Federation		
Krymsk Azov Shipping Co. Santierul Naval Galatz		Marinpol	1964	First	RR Russian Federation		6728874
Kulunda Far-Eastern Shipping Co. / Vladivostok		Vladivostok	1970		RR Russian Federation		
Kuznetsk Sakhalin Shipping Co.		Kholmsk	1969		RR Russian Federation		

Stepan Savushkin Sakhalin Shipping Co.	Kholmsk	1969	RR Russian Federation
Tymovsk Sakhalin Shipping Co.	Kholmsk	1970	RR Russian Federation
Yevgeniy Chaplanov Sakhalin Shipping Co.	Kholmsk	1970	RR Russian Federation

Krystall			1 ships	L1	rank: 4	
152.70	22.00	13.60	SSDG	1	17.4	REFR
142.00		12380		FPP	—	
—			7600	4	—	35
—			—	—	—	—
7.96	16600	9400				

8380 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Krystall		1985	First	RR		
Major modernization in 1993 included: replacement of the original steam turbo- electric plant with a diesel-electric system. Original 6.7 MW propulsion motors were retained. Bow was also replaced.						

Kulluk			IAA				rank: 3
81.00	81.00	18.50	—	—	—	—	DRIR
—	—	29147	—	—	—	—	
12.53	—	—	—	—	—	—	
—	—	—	—	—	—	—	

Non-self-propelled barge
drilling unit.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kulluk				ABS		
	Vancouver, B.C.					
Mitsui SB & Engineering Co., Ltd.						

LadogaLes			6 ships		L1		rank: 4	
102.34	13.85	6.89	SSDG	—	13.8	CONV	MPC	
93.02	14.03	2866	—	—	7600	—	TIMB	
5.91	5356	3455	2133	4	—	24		
—		3796	—	—	—	—		

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Indiga		1965		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Kolguyev		1965		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
KostromaLes		1964		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Ladogales		1964	First	RR		6412097
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Valmet Oy Helsingin Telakka						
NevaLes		1965		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Saldus		1965		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		

Lena		
130.20	19.00	10.62
117.30	19.25	5753
8.27	12600	7439
8.70		7986

ULA

rank: 2

DIEL	1	14.0	CONV	MPC
4235	FPP	1350 n. mi.	—	
6200	4	—	—	
—	—	—	—	
0.73m @ 2kn				

5730 t. cont: 461 @ 20', cranes:
2 @ (60-150 t.)

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Lena	Hamburg	1957	First	GL	Russian Federation	8902321

Lenin			1 ships		LL2		rank: 1	
134.00	26.80	16.10	NPTE	3 1:2:1	19.7		CONS	
124.00	27.60		28800	FPP	Unlimited		30	
10.40	19240		32360	4	—		—	
—			—	—	—		—	
			1.65 m. @2 kn.					

Ship decommissioned.

Tsoy (1992); Tsoy (1993);
Tsoy (1990)

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Lenin			1959	First	RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Admiralty Ship Yard							

Libby G**A****rank: 3**

18.80	10.20
117.00	5267
7.47	11565 7766
—	—

—	—	15.0	—	CHEM
—	—	—	—	TANK
4530	4	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							

Libby G

Libby G.

Nippon Kokan K.K.Tsu Shipyard

Monrovia

1980

ABS
Liberia

8010845

Louis S. St. Laurent			1 ships	4	rank: 1		
112.00	24.38	13.10	DIEL	3 1:1:1	17.8	CGIB	
101.86		10908	17900	FPP	16600 n.mi.		
9.40	13300		4				
8.99							
10.30		4714	2 m.@4 kn.				

Dick; Tsoy (1993); MER
01/94; Wind.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Louis S. St. Laurent		Ottawa	1969	First	CR		6705937
Transport Canada (Gov't of Canada)					Canada		
Canadian Vickers Shipyard Ltd.							

Lunni			4 ships	IA Super			rank: 3
164.50	21.50	12.00	MSDG	1	14.5	—	TANK
154.00	22.26	11290	—	CPP	—	—	
9.50		16000	11500	4 5.5	—	—	
—			—	—	—	—	
			1.0 m.@2 kn.				

Pumps: 8

A former sister tanker from this series, the "Uikku", was converted in 1993 to accomodate azimuthing propulsion drive "Azipod". See under series name "Uikku".

Air bubbling system installed.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Lunni		1976	First	DNV		7421942
Neste Oy	Naantali/Nadendal			Finland		
Verft Nobizkrug Gmbh.						

Marinor		
112.20	18.00	9.50
104.66		4950
7.50		7500
9.50		

IA

rank: 4

SSDG	1	14.5		
4050	CPP		90	CHEM
	4.5	570 t.	22	TANK

8500 m³, pumps: 9, all 12 tanks are constructed of Avesta type-220S stainless steel.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Marinor		1992		LR		9043794
	Harlingen					

Mariya Yermolova**L1****rank: 4**

100.00	16.21	7.00	SSDG	—	17.0	CONV	FERR
90.00	16.24	3941	—	—	—	—	PASS
—	—	—	38821	4	—	—	—
4.65	—	1465	—	—	—	—	—
—	—	—	—	—	—	—	—

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Alla Tarasova			1975		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Antonina Nezhdanova			1978		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Klavdia Yelanskaya			1977		RR		7422922
Murmansk Shipping Co.		Murmansk			Russian Federation		
Lyubov Orlova			1976		RR		7391434
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Mariya Savina			1975		RR		7391410
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Titovo Brodogradiliste							
Mariya Yermolova			1974	First			7367524
Murmansk Shipping Co.		Murmansk			Russian Federation		
Olga Sadovskaya			1977		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		

Mary Christina

IA

rank: 4

87.90	7.70	MSDG	1	12.5	CONV	BULK
84.90	12.30	—	—	—	45	CONT
—	—	1850	—	—	8	—
5.30	4536	—	—	—	Thrusters	—
—	—	—	—	—	—	—

5548 m^3.

Bow thrusters @200 kW.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Mary Christina

Mekhanik Yartsev			10 ships		L1		rank: 4	
85.20	14.20	6.00	SSDG	1	12.6	CONV	BULK	
79.40	14.50	2489		CPP	5000 n. mi.		TIMB	
4.70		2291	2074	4 2.9	170 t.	20		
						Thrusters		
5.05		2636						

2 cargo holds 1184 m³ & 1727 m³,
cranes @5 t. @20 m.

Bow thrusters @185 kW.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Mekhanik Brillin			1991		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Osterreichische Schiffswerften A.G. Linz							
Mekhanik Fomin			1991		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Mekhanik Kotsov			1991		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Mekhanik Makarjin			1991		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Mekhanik Pustoshnyi			1992		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Mekhanik Pyatlin			1992		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Mekhanik Yartsev			1990	First	RR		8904367
Northern Shipping Company		Arkhangelsk			Russian Federation		
Osterreichische Schiffswerften A.G. Linz							

Mikhail Kalinin**L1****rank: 4**

122.15	15.96	7.62	—	1	18.0	CONV	PASS
109.99	16.03	5243	—	FPP	—	—	—
—	—	—	6106	4	—	—	—
—	—	—	—	—	—	—	—
5.85	—	1358	—	—	—	—	—

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Baykal		1963		RR		
Baikal Shipping Co.						
Estonia		1960		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Mikhail Kalinin		1958	First	RR		5234917
Baltic Shipping Co.	St. Peterburg			Russian Federation		
VEB Mathias-Thesen-Werft						
Nikolayevsk		1962		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Petropavlovsk		1960		RR		
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii			Russian Federation		

Mikhail Somov		
133.13		
—	18.85	7696
—		
11.61		8220
—		
9.05		

1	ships	UL	rank: 3
DIEL	—	—	ASRV
—	—	—	RV
—	—	—	
—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Mikhail Somov

Arctic and Antarctic Research Institute
Wartsilla Shipyards

1975 First

Mikhail Strekalovski			14 ships		UL		rank: 3	
162.10	22.86	13.50	SSDG	1	15.2	CONV	BULK	
154.88	22.92	13950	7430	FPP	6000 n.mi.			
			8240	4		26		
9.88	27340	19252						

18104 t., cont: 442@20', cranes:
6@12.5 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Anatoliy Lyapidevskiy		1984		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Ivan Makarjin		1981		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Kapitan Bochek		1982		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Kapitan Chukhchin		1981		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Kapitan Kudlay		1983		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Kapitan Nazarjev		1984		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Kapitan Sviridov		1982		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Kapitan Tsirul'		1981		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Kapitan Vakula		1983		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Kapitan Vodenko		1982		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Mikhail Strekalovski		1981	First	RR		8131881
Murmansk Shipping Co.	Murmansk			Russian Federation		
VEB Warnowwerft Warnemuende						

Pavel Vavilov Murmansk Shipping Co.	Murmansk	1981	RR Russian Federation
Tim Bak Murmansk Shipping Co.	Murmansk	1983	RR Russian Federation
Victor Tkachev Murmansk Shipping Co.	Murmansk	1982	RR Russian Federation

Mirnyy			46 ships	L1	rank: 4	
102.27	14.00	6.89	—	1	13.5	CONV
93.02	14.03	2920	—	FPP	—	MPC
6.20		3930	2133	4	—	TIMB
—			—	—	—	

Dick; MER 01/94.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Blagoveshensk		1969		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Chazhma		1968		RR		
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii			Russian Federation		
Guse-Khrustalnyi		1970		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Iljinsk		1967		RR		
DVVIMU				Russian Federation		
Jose Diaz		1967		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Kaliningrad		1969		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Kamchadal		1969		RR		
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii			Russian Federation		
Kamchatskiy Komsomolets		1968		RR		
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii			Russian Federation		
Kapitan Gastello		1967		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Kharlov		1968		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Kikhchik		1971		RR		
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii			Russian Federation		

Kimry Baltic Shipping Co.	St. Petersburg	1969	RR Russian Federation	
Kingisepp Baltic Shipping Co.	St. Petersburg	1969	RR Russian Federation	
Koporje Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1968	RR Russian Federation	
Kozyrevsk Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii	1971	RR Russian Federation	
Krasnoborsk Baltic Shipping Co.	St. Petersburg	1970	RR Russian Federation	
Krasnoyarsk Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii	1968	RR Russian Federation	
Kuzminki Baltic Shipping Co.	St. Petersburg	1970	RR Russian Federation	
Ligovo Baltic Shipping Co.	St. Petersburg	1967	RR Russian Federation	
Lomonosovo Baltic Shipping Co.	St. Petersburg	1968	RR Russian Federation	
Mirnyi Kamchatka Shipping Co. USSA	Petropavlovsk-Kamchatskii	1967	First RR Russian Federation	6617441
Palana Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii	1967	RR Russian Federation	
Pervouralsk Sakhalin Shipping Co.	Kholmsk	1966	RR Russian Federation	
Shushenskoye Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii	1970	RR Russian Federation	
Sofja Perovskaya Baltic Shipping Co.	St. Petersburg	1967	RR Russian Federation	
Tampere Sakhalin Shipping Co.	Kholmsk	1967	RR Russian Federation	

Tobol Sakhalin Shipping Co.	Kholmsk	1969	RR Russian Federation
Turku Baltic Shipping Co.	St. Petersburg	1967	RR Russian Federation
Vaga Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii	1967	RR Russian Federation
Velikiy Ustyug Baltic Shipping Co.	St. Petersburg	1969	RR Russian Federation
Yantarnyi Baltic Shipping Co.	St. Petersburg	1968	RR Russian Federation

Molikpaq			IAA				rank: 3
	111.00	29.00					DRIR
111.00		42317	—	—	—	—	
21.30			—	—	—	—	
—			—	—	—	—	

Caisson drilling unit.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Molikpaq				ABS		8402266
	Vancouver, B.C.					
Ishikawajima-Harima Heavy Ind.Co.Ltd.						

Moskva		
122.10	23.50	14.00
112.40	24.50	9427
9.50	13290	
10.50	15400	6147

5 ships

LL3

rank: 1

DIEL	3	1:2:1	18.3	CONS	IB
16200	FPP		38 days	26	
19120	4			85	
226					
1.4 m.@2 kn.					

cranes: 2@10 t. 2@1.5 t.

Dick; Tsoy (1993); Tsoy (1992); Tsoy (1990).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kiev			1965		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Leningrad			1961		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Moskva			1960	First	RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Wartsilla Shipyards							
Murmansk			1968		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Vladivostok			1969		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		

Mudyug			3 ships		LL3		rank: 1	
88.60	20.00	10.50	MSDG	2	16.1	CONS	IB	
78.50	21.20	5342	7000	CPP	30 days	26	TUG	
6.00	5560		9560	4 4.0	—	32		
—			—	—	—	—		
—	7250	1909	0.98 m.@2 kn.					

Orlano-Erenya; Simonov;
Tsoy (1993); Tsoy (1992);
Tsoy (1990); Zakharov.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Dikson			1983		RR	Russian Federation	
Magadan			1982		RR	Russian Federation	
Far-Eastern Shipping Co. / Vladivostok		Vladivostok					
Mudyug			1982	First	RR	Russian Federation	
Wartsilla Shipyards		This ship was converted to Thyssen-WAAS bow shape in 1989. The new dimensions are: LOA=111.4 m.; Lwl=89.8 m.; Bmax=22.2 m.; Displ. @wt=6880 t.; Icebreaking capability in level ice is 1.5 m.@2 kn.					

Nathaniel B. Palmer**A2****rank: 2**

94.05	18.29	9.45	MSDG	2	15.0	SLED	IB
85.27		6174	9500	CPP	75 days	30	RV
6.63	6384		9900	4 4.0	1639 t.	26	
—		2500	—	—	—	—	

Accommodates 27 scientists.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Nathaniel B. Palmer		1992		ABS		9200734
	Galliano					
North American SB, Inc.						

Nikolay Novikov			25 ships		L1		rank: 4	
150.08		11.60	SSDG	1	15.5	CONV	BULK	
139.86	20.98	10185	6360	FPP	12000 n.mi.		TIMB	
—			7060	4	—	26		
—			—	—	—	—		
8.69	19730	13955						

11910 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Botman Moshkov			1976		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Fyodor Varaskin			1977		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Ivan Syrykh			1973		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kapitan Bakanov			1974		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kapitan Burmakin			1976		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Kapitan Dublitskiy			1975		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kapitan Glazachev			1976		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Kapitan Kiri			1974		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Kapitan Lyubchenko			1976		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kapitan Milovzorov			1975		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kapitan Mochalov			1974		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		

Kapitan Samoylenko Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1975		RR Russian Federation	
Kapitan Shevchenko Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1976		RR Russian Federation	
Kapitan Vasilevskiy Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1976		RR Russian Federation	
Kapitan Zamyatin Northern Shipping Company	Arkhangelsk	1975		RR Russian Federation	
Konstantin Petrovskiy Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1974		RR Russian Federation	
Mekhanik Gordienko Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1973		RR Russian Federation	
Nikolay Novikov Northern Shipping Company Stocznia Gdanska im. Lenina	Arkhangelsk	1973	First	RR Russian Federation	7301104
Pyotr Smidovich Northern Shipping Company	Arkhangelsk	1975		RR Russian Federation	
Pyotr Strelkov Northern Shipping Company	Arkhangelsk	1977		RR Russian Federation	
Vasilliy Musinskiy Northern Shipping Company	Arkhangelsk	1975		RR Russian Federation	
Vladimir Mordvinov Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1973		RR Russian Federation	
Vladimir Timofeyev Northern Shipping Company	Arkhangelsk	1973		RR Russian Federation	
Vlas Nichkov Northern Shipping Company Stocznia Gdanska im. Lenina	Arkhangelsk	1974	First	RR Russian Federation	7362419
Yuriy Savinov Sakhalin Shipping Co.	Kholmsk	1976		RR Russian Federation	

Nikopol			6 ships		L1		rank: 4	
83.42		5.31	SSDG	1	13.2	CONV	TANK	
74.00	12.02	1630		FPP	2500 n.mi.			
			1470	4		25		
4.65	2920	1660						

1540 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Nikopol	Baskunchak		1964	First	RR		7029639
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Kerch Shipyard							

Norilsk (a.k.a. SA-15)**14 ships****ULA****rank: 2**

174.00	24.00	15.20
164.00	24.50	16500
8.50	24100	12900
9.00	25900	14700
10.50	31200	20000

MSDG	1	17.0	CONS	BULK
14200	CPP	12000 n.mi.	30	CONT
15400	4 5.6	—	39	MPC
160	—	—	—	—
1.0m.@2 kn.				

8555 t. @wl; 10345 t. @arc; 15700 t. @max.

Cargo helicopter "ka-32C", 5 ton capacity;
2 ACVs, 20 ton capacity.

Hangar and landing pad.

Air-bubbling and water jet system.

Low-friction, abrasion-resistant coating.

Narby; Simonov; Tsoy (1993);
Tsoy (1992); Tsoy (1990).**SISTER SHIPS**

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Anderma			1983		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Anadyr			1984		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Arkhangelsk			1983		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Bratsk			1983		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Igarka			1983	First	RR		8013027
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Oy Wartsila Ab							
Kandalaksha			1984		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Kemerovo			1983		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Kola			1983		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Monchegorsk			1983		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Nikel			1984		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		

Nizhneyarsk Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1983		RR Russian Federation
Norilsk Murmansk Shipping Co. Wartsilla Shipyards	Murmansk	1982	First	RR Russian Federation
Okha Sakhalin Shipping Co.	Kholmsk	1983		RR Russian Federation
Tiksi Murmansk Shipping Co.	Murmansk	1983		RR Russian Federation

Norse Mersey**IA Super****rank: 3**

178.70	23.68	17.35	—	2	18.0	—
166.47	24.54	20914	—	CPP	—	—
—	—	—	8200	—	—	—
5.72	—	14800	—	—	—	—
—	—	—	—	—	—	—

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Novaya Ladoga (Pr. 596)**L1****rank: 4**

121.95	16.69	8.31	MSDG	—	15.7	—	MPC
113.01	16.74	4676	—	—	—	—	
5.99		6460	3825	—	—	—	
—			—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Bakaritsa			1968		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Isakogorka			1968		RR		6909571
Northern Shipping Company		Arkhangelsk			Russian Federation		
Zhdanov Shipyards							
Komsomolets Sakhalina			1971		RR		7121449
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Vyborg Shipyard							
Kuloy			1967		RR		6919162
Northern Shipping Company		Archangelsk			Russian Federation		
Vyborg Shipyard							
Maymaksa			1968		RR		6912176
Northern Shipping Company		Arkhangelsk			Russian Federation		
Vyborg Shipyard							
Novaya Ladoga			1967	First	RR		6906634
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Zhdanov Shipyards							
Oka			1967		RR		6909583
Northern Shipping Company		Arkhangelsk			Russian Federation		
Vasya Alekseyev			1967		RR		6906672
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Zhdanov Shipyards							
Vostok-2			1965		RR		6914617
Northern Shipping Company		Arkhangelsk			Russian Federation		
Zhdanov Shipyards							
Zolotitsa			1967		RR		6909595
Northern Shipping Company		Arkhangelsk			Russian Federation		
Zhdanov Shipyards							

Novy Donbass			2	ships	L1	rank: 4	
100.60	13.90	8.10	SSDG	1	13.2	CONV	MPC
90.00		2354	1656	FPP	5000 n.mi.		
			1840	4		24	
5.50	5125	2990					

2651 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Novy Donbass		1963	First	RR		6419617
Ukraine D.S.	Izmail			Ukraine		
Santierul Naval Galatz						

Oden			1 ships	Polar-20	rank: 1
107.80	25.00	12.00	2	17.0	IB
93.20	31.08	9438	7720 CPP	30000 n.mi.	
7.00	13000		18000 4		
8.50		4906	1.8m.@3 kn.		

Helicopter deck.

12000 n.mi. range in 0.9 m.
thick ice

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Oden		Stokholm	1989	First	DNV		8700876
Svensk Isbrytarkonsortium KB					Sweden		
Gotaverken Arendal AB							

Otso			2 ships			rank: 1	
99.00	23.50	11.30	DIEL	2	18.5	CONS	IB
90.00	24.20	6000	15000	CPP	—	30	
—	—	—	21840	4	—	28	
8.00	8500	4900	—	Nozzles	—	—	
—	—	—	—	—	—	—	
8.50	13000	2000	1.4 m.				

Air bubbling system installed.
Stainless steel belt plating in ice
contact zone.

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Kontio		1987		FR		
				Finland		
Otso		1986	First	FR	FR	8405880
Finnish Board of Navigation	Helsinki			Finland		
Wartsilla Shipyards						

Otto Schmidt			1 ships		LL4		rank: 2	
112.00	18.62	8.31	DIEL	2	15.0	CONV	IB	
73.00	19.80	2828	3975	FPP	—	29	RV	
—	3700		—	4	—	—		
—			—	—	—	—		
6.62		1095						

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Otto Schmidt		1979	First	RR		7828671
Murmansk Hydrometeorology	Murmansk			Russian Federation		
Admiralty Ship Yard						

Pandora II			IAA				rank: 3
55.76	13.72	5.03	DIEL	2	20.0		MSH
53.32	13.75	1378		CPP		—	SUPP
4.43			3824	4		—	
—						—	
—						—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		HOME PORT		FLAG		
SHIPYARD		(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)		(CHARTER RATE AND OP. COSTS)				

Pandora II		1974		ABS	
Northern Shipping Company	Halifax			Canada	
Bel-Aire Shipyard,Ltd.					

Partizansk			11 ships		UL		rank: 3	
97.35	14.20	6.50	MSDG	1	13.5		CONV	TANK
90.10	14.23	2968		CPP	2500n.mi			
		2500	2870	4			23	
4.90	4855	2833						

2350 t., 3230 m³

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Angarsk			1990		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Arsenyev			1989		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Belogorsk			1988		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Guryev			1990		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Kotlas			1989		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Partizansk			1988	First	RR		8700096
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Oy Laivateollisuus Ab							
Petropavlovsk-Kamchatsk			1989		RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		
Roschino			1990		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Shkotovo			1990		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Svobodnyi			1989		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		

Pavlin Vinogradov			7 ships		UL		rank: 3	
131.60	19.30	8.80	SSDG	1	14.9	CONV	MPC	
122.00		6395		FPP	6500n.mi			
			4690	4		30		
7.00	11249	7850						

5800 t., cont: 274@20', cranes:
4@18.5 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Anatoliy Sibiryakov			1989		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Iogann Makhmatal'			1990		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Kapitan Glotov			1989		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Kapitan Ponomaryov			1990		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pavlin Vinogradov			1987	First	RR		8419128
Northern Shipping Company		Arkhangelsk			Russian Federation		
Stocznia Gdanska im. Lenina							
Teodor Nette			1988		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		

Petrozavodsk			20 ships		L1		rank: 4	
121.95	16.69	8.31	—	1	15.8	—	CONV	MPC
112.78	16.74	4562	—	FPP	—	—	—	—
—	—	—	3825	4	—	—	—	—
—	—	—	—	—	—	—	—	—
7.15	—	6540	—	—	—	—	—	—

cranes: 4@5 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Palanga			1969		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Paramushir			1971		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pargolovo			1970		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Paromay			1971		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pavlovo			1971		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pechenga			1970		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Perm'			1969		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pertominsk			1968		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Petrokrepost			1970		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Petrovskiy			1970		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Petrozavodsk			1968	First	RR		6923072
Northern Shipping Company		Arkhangelsk			Russian Federation		
Vyborg Shipyard							

Plesetsk Northern Shipping Company	Arkhangelsk	1968	RR Russian Federation
Pomorje Northern Shipping Company	Arkhangelsk	1969	RR Russian Federation
Ponoy Northern Shipping Company	Arkhangelsk	1969	RR Russian Federation
Poronaysk Sakhalin Shipping Co.	Kholmsk	1972	RR Russian Federation
Primorje Sakhalin Shipping Co.	Kholmsk	1971	RR Russian Federation
Przhevalsk Sakhalin Shipping Co.	Kholmsk	1971	RR Russian Federation
Pulkovo Northern Shipping Company	Arkhangelsk	1970	RR Russian Federation
Pushlakhta Northern Shipping Company	Arkhangelsk	1971	RR Russian Federation
Pustozersk Northern Shipping Company	Arkhangelsk	1969	RR Russian Federation

Piere Radisson			3 ships		2		rank: 2	
98.20	19.00	10.80	DIEL	2	16.0		CGIB	
88.00	19.50	5910	10000	FPP	15000n.mi	18		
			13010	4 4.1	1800 t.	75		
7.20	8315	2865	1.15m @ 2kn					

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Franklin			1979		CR		
Department of the Coast Guard (Canada)	Ottawa				Canada		
Burrard Yarrows Co							
Grosselier			1983		CR		
Department of the Coast Guard (Canada)	Ottawa				Canada		
Burrard Yarrows Co							
Piere Radisson			1978	First	CR		7510834
Department of the Coast Guard (Canada)	Ottawa				Canada		
Burrard Yarrows Co							

Pioner			30 ships		L1		rank: 4	
105.69	15.60	8.00	SSDG	1	13.8	CONV	MPC	
96.00	15.63	3601	2150	FPP	8000n.mi	—		
			2390	4		24		
—					—			
6.79	7240	4668	—	—	—	—		

4087 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Arkadiy Kamanin		1972		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Borya Tsarikov		1971		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Kolya Myagotin		1969		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Lara Mikheyenko		1968		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Lyonya Golikov		1968		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Marat Kazey		1968		RR		
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskii			Russian Federation		
Nina Kukoverova		1970		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Pavlik Larishkin		1971		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		
Pioner		1968	First	RR		6727014
Kamchatka Shipping Co.	Petropavlovsk-Kamchatskiy			Russian Federation		
Veb Shiftswerft Neptun						
Pionerskaya Zor'ka		1972		RR		
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		
Sasha Borodulin		1970		RR		
AIF Shipping Company				Russian Federation		

Sasha Kondratyev Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1969	RR Russian Federation
Sasha Kotov Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1972	RR Russian Federation
Shura Kober Murmansk Shipping Co.	Murmansk	1971	RR Russian Federation
Tolya Bodarchuk Murmansk Shipping Co.	Murmansk	1972	RR Russian Federation
Tolya Komar Polar Chart Company		1971	
Tolya Shumov Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1970	RR Russian Federation
Valeriy Volkov Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1970	RR Russian Federation
Valya Kotik Murmansk Shipping Co.	Murmansk	1968	RR Russian Federation
Vasya Korobko Murmansk Shipping Co.	Murmansk	1970	RR Russian Federation
Vitya Chalenko Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1971	RR Russian Federation
Vitya Khomenko Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1971	RR Russian Federation
Vitya Sitnitsa Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1971	RR Russian Federation
Volodya Sherbatsevich Murmansk Shipping Co.	Murmansk	1972	RR Russian Federation
Yuta Bondarovskaya Murmansk Shipping Co.	Murmansk	1970	RR Russian Federation
Zina Portnova Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1968	RR Russian Federation

Pioner Moskvyy			22 ships		UL		rank: 3	
129.95	17.00	8.54	SSDG	1	15.6	CONV	MPC	
119.03	17.33	4814	4050	FPP	6500n.mi			
			4490	4		25		
7.34	10010	6780						

5265 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Pavel Korchagin			1980		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pioner Arkhangelska			1974		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pioner Belorussii			1978		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pioner Buryatii			1977		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pioner Chukotki			1975		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Pioner Estonii			1976		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pioner Kamchatki			1976		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pioner Karelii			1978		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pioner Kazakhstana			1979		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Pioner Kholmska			1974		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pioner Kirghizii			1978		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		

Pioner Litvy Northern Shipping Company	Arkhangelsk	1977		RR Russian Federation	
Pioner Moldavii Northern Shipping Company	Arkhangelsk	1979		RR Russian Federation	
Pioner Moskvyy Northern Shipping Company Vyborg Shipyard	Arkhangelsk	1973	First	RR Russian Federation	7334785
Pioner Oneghi Northern Shipping Company	Arkhangelsk	1975		RR Russian Federation	
Pioner Rossii Sakhalin Shipping Co.	Kholmsk	1976		RR Russian Federation	
Pioner Severodvinska Northern Shipping Company	Arkhangelsk	1975		RR Russian Federation	
Pioner Slavyanki Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1975		RR Russian Federation	
Pioner Uzbekistana Sakhalin Shipping Co.	Kholmsk	1980		RR Russian Federation	
Pioner Yakutii Northern Shipping Company	Arkhangelsk	1977		RR Russian Federation	
Pioner Yu. Sakhalinska Sakhalin Shipping Co.	Kholmsk	1974		RR Russian Federation	

Polar Circle		
91.00	17.90	9.30
82.50		5129
6.50		2200
—		

IA Super				rank: 3
MSDG	1	14.9	CONV	PASS
	CPP	—		RV
6000	4 4.0	—	35	
	Nozzles	—		
1 m. @3 kn.				

2100 t. + 24 cont. + 95 pass.

Double-hull design.

Bow & stern thrusters.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Polar Circle		1990	First	DNV		8901561
UK Navy Dept.				Great Britain		
Ulstain Hatlo A/S						

Polar Duke			1 ships	IAA	rank: 3		
66.80	13.10	9.50	—	1	14.0	—	RV
58.20		1649	—	CPP	12000 n.mi./90 days	—	
5.80	1400		3300	4 2.8	870 t.	14	
5.20			—	—	—	—	

cranes: 1@12.5 t.

Room for 26 persons, plus crew

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Polar Duke		1983	First	DNV		
	Bergen			Norway		
Vaagen Verft						

Polar Star			2 ships			rank: 1		
121.60	24.40	13.20	TUEL	3	21.0	CONV	CGIB	
107.30	25.50		—	CPP	28300n.mi	15		
8.50			13235	4 4.9	—	138		
—		44700	—	—	—	—		
—	13190		1.83m @ 3kn					

Hangar and landing pad for 2
helicopters.

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Polar Sea			1978		ABS		
US Coast Guard		Seattle, WA			U.S.A.		
Lockheed SB & Construction Co							
Polar Star			1976	First	ABS		7367471
US Coast Guard		Seattle, WA			U.S.A.		
Lockheed SB & Construction Co							

Polarstern			1 ships	Arc2		rank: 1	
118.00	24.40	13.60	MSDG	2	16.6	CONV	IB
102.20	25.00	10878	12400	CPP	—	22	RV
10.50	15000		14700	4 4.1	—	36	SUPP
—			230	Nozzles	—	—	
		4374	1.0m@5.2kn				

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Polarstern			1982	First	GL		8013132
Bundesminister fur Forschung und Tech. (Germany)					Germany		
Howaldtswerke - Deutsche Werft AG							

Posiet			4 ships	L1	rank: 4	
103.00	17.00	9.65	SSDG	1	17.0	CONV
93.40		4295		FPP	10000n.mi	REFR
			7502	4		18
7.20	7121	3657				

2825t., cont: 62@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Gorno-Altaysk						
Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1990		RR	Russian Federation	
Posyet						
Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1988	First	RR	Russian Federation	8576615
Hellenic Shipyards						
Slavyanka						
Far-Eastern Shipping Co. / Vladivostok	Vladivostok	1989		RR	Russian Federation	

Povenets			23 ships	L1	rank: 4	
105.85	14.60	8.00	SSDG	1	13.5	CONV
96.00		3726	2150	FPP	8000n.mi	MPC
—			2390	4	—	24
—			—	—	—	—
6.56	6681	4150				

3832 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Bukhtarma			1966				
Aspol Shipping Co. Ltd.		Murmansk					
Kovdor			1967		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Murman			1967		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Olenegorsk			1965		RR		
Murmansk Shipping Co.		Murmansk			Russian Federation		
Povenets			1963	First	RR		
Svirsk			1966				
AKFES Shipping							
Ussuri			1966		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		

Professor Goryunov**L1****rank: 4**

110.10	9.10	—	1	13.8	—	DRED
101.00	20.40	—	CPP	—	—	
6.50	5400	7156	4	—	48	
—		—	—	—	Thrusters	

Bow thrusters @500 kW.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Professor Goryunov		1986		RR		8505678
IHS Smith	Vyborg			Russian Federation		

Rheinstern			4 ships	E3	rank: 4	
161.36	11.70		MSDG	14.7	CONV	CHEM
153.00	23.00		—	8000	45	TANK
8.50	17000		6600	—	23	
8.60			—	—	—	

20340 m^3

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Rheinstern		1993		GL		
Rigel Schiffahrts						
MTW Schiffbau Werft						

Sakhalin-1		10 ships	UL		rank: 3	
—	5025	DIEL	2	16.8	CONV	FERR
—		2820	4	—	—	PASS
—		—	—	—	—	RORO
—	2427	—	—	—	—	

rail vehicles: 26, stern door

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Sakhalin-1		1972	First	RR		7223601
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Kaliningrad Shipyard						
Sakhalin-10		1992		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-2		1973		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-3		1974		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-4		1975		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-5		1976		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-6		1978		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-7		1982		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-8		1984		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		
Sakhalin-9		1986		RR		
Sakhalin Shipping Co.	Kholmsk			Russian Federation		

Samotlor			14 ships		UL		rank: 3	
160.00	23.00	12.90	SSDG	1	15.7	CONV	TANK	
148.00	23.04	13204		FPP	10000n.mi			
—			8538	4	—	25		
—			—	—	—	—		
9.20	24570	17200						

15180 t., pumps: 6

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
BAM			1977		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Beryozovo			1975		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Gornopravdinsk			1976		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Igrim			1978		RR		7413476
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Rauma-Repola Oy							
Kamensk-Uralskiy			1977		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Nadym			1976		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Nizhnevartovsk			1976		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Samotlor			1975	First	RR		7359333
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Rauma-Repola Oy							
Urengoy			1975		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Usinsk			1976		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		
Viluysk			1977		RR		
Primorsk Shipping Co.		Nakhodka			Russian Federation		

Yeniseysk

1977

RR

Primorsk Shipping Co.

Nakhodka

Russian Federation

Seapower			IA				rank: 4
—	12.80	5.80	—	—	—	—	SUPP
60.39		919	—	—	—	—	
4.77			5176	4	—	—	
—			—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		HOME PORT		FLAG		
SHIPYARD		(MODERNIZATION)		(NOTES)		
(SPECIAL FEATURES)		(CHARTER RATE AND OP. COSTS)				

Seapower				ABS		7500706
Teraoka SB Co.Ltd.	Panama					

Sergei Kirov			2 ships		L1		rank: 4	
156.60	23.80	16.90	SSDG	2	17.6	CONV	RORO	
142.00		6789	7920	CPP	12000n.mi			
—			8700	4	—	23		
—			—	—	—	—		
8.83	21260	12010						

9940 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Pavlovsk		1992		RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Sergei Kirov		1989	First	RR		
Baltic Shipping Co.	St. Petersburg			Russian Federation		

Sestroretsk			5 ships		UL		rank: 3	
130.30	17.30	8.50	SSDG	1	15.2		CONT	
119.00	17.35	4786		FPP	7300n.mi			
—			4046	4	—	—		
—					—	—		
6.91	9826	6010			—	—		

3815 t., cont: 218@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Pioner Nakhodki			1972		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Pioner Primorya			1973		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Pioner Vladivostoka			1972		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Pioner Vyborga			1973		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Sestroretsk			1972	First	RR		7203261
Baltic Shipping Co.		St. Peterburg			Russian Federation		
Vyborg Shipyard							

SevMorPut			1 ships		ULA		rank: 2	
260.30	31.60	18.30	NPTE	1	20.8	CONV	LASH	
228.80	32.20	38226	21625	CPP	Unlimited	30		
10.70	54380	25480	29410	4 6.7	—	70		
—	—	—	350	Nozzles	—	—		
11.70	61880	33980	1.5m					

29700 t. @Dwtmax; 22200 t. @Dwl,
124 lighters or 1324 cont.

Ivanov; Sytov; Simonov; Tsoy
(1993); Tsoy (1992); Tsoy
(1990).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
SevMorPut			1988	First	RR		8729810
Murmansk Shipping Co.		Murmansk			Russian Federation		
Zaliv Shipyard							

Shiraze			1 ships			rank: 1		
134.00	27.00	14.50	DIEL	3	19.0	CONV	ASRV	
127.00	28.00			FPP		21	IB	
				4	4.9		RV	
9.80	18600							
9.50								
			1.5m @ 3kn					

Dick; Tsoy (1993).

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Shiraze 1982 First

Mitsubishi Heavy Industries

Shuhle Geteborg**IA****rank: 4**

87.50	5.00	1				BULK
82.50	13.00	2000	CPP	—	—	TANK
3.60	2050	2370	4 2.7	—	—	
—			Nozzles	—	—	

1540 t. of lumber materials or 2500
m³ of oil.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Shuhle Geteborg		1990		DNV		

SibirLes			12 ships		L1		rank: 4	
104.40	14.33	7.12	SSDG	1	13.5	CONV	MPC	
94.50	14.37	3179	1910	FPP	6000n.mi			
			2130	4		24		
6.37	6000	4140						

3379 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Aldan			1967				
Ayan			1966		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Egvekinot			1965		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Kem'			1967		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Korsakov			1965				
Sakhalin-Lyaonin					Russian Federation		
Lakhta			1967		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Omolon			1966		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
SibirLes			1964	First	RR		6505363
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Nosenko Shipyard							
Sibirtsevo			1965		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Terney			1965		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
VyatkaLes			1965		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		

Vznorje Sakhalin Shipping Co.	Kholmsk	1966	RR Russian Federation
Yana Sakhalin Shipping Co.	Kholmsk	1966	RR Russian Federation

Sibirski					rank: 4
—	1250	—	—	—	BULK
—	—	—	—	—	TANK
—	—	—	—	—	
—	—	—	—	—	
3200					

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Sibirski 2101			1980	First	RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2102			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2103			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2104			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2105			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2106			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2107			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2108			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2109			1980		RR	Russian Federation	
Wartsilla Shipyards							
Sibirski 2121			1980		RR	Russian Federation	
Wartsilla Shipyards							

Sosnovets				11 ships		L1		rank: 4			
<div><div>80.195.60</div><div>71.2011.941531</div><div>—</div><div>—</div><div>4.6028351635</div></div>				<div><div>MSDG1</div><div>990FPP</div><div>11004</div><div>—</div></div>		<div><div>12.2</div><div>4000n.mi</div><div>—</div><div>—</div></div>		<div><div>CONV</div><div>21</div><div>—</div></div>		<div><div>MPC</div></div>	

1425 t., cranes: 3@5 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Cherepovets			1970		RR		
Northern Shipping Company		Arkhangelsk			Russian Federation		
Sernovodsk			1972		RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		
Slautnoye			1973		RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		
Snezhnogorsk			1972		RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		
Soflysk			1973		RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		
Sosnovets			1970	First	RR		7108033
Northern Shipping Company		Arkhangelsk			Russian Federation		
Interprinderea Const. Navale Constanza							
Surgut			1973		RR		
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		

Sovetskaya Yakutiya			8 ships		L1		rank: 4	
123.50	15.00	6.50	MSDG	2	11.2	CONV	MPC	
117.00	15.04	3590	1324	FPP	5000n.mi			
—			1472	4	—	24		
—			—	—	—	—		
4.50	6142	4000						

3700 t., cranes: 2@8 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Afanasiy Bogatyryov			1973		RR		
YakutMorTransObyedineniye					Russian Federation		
Fyodor Okhlopkov			1974		RR		
YakutMorTransObyedineniye					Russian Federation		
Fyodor Popov			1974		RR		
YakutMorTransObyedineniye					Russian Federation		
Isidor Barakhov			1974		RR		
YakutMorTransObyedineniye					Russian Federation		
Ivan Strod			1975		RR		
YakutMorTransObyedineniye					Russian Federation		
Maksim Anmosov			1975		RR		
YakutMorTransObyedineniye					Russian Federation		
Platon Oiunskiy			1975		RR		
YakutMorTransObyedineniye					Russian Federation		
Sovetskaya Yakutiya			1972	First	RR		7235355
Northern Shipping Company		Arkhangelsk			Russian Federation		
Navashinskiy Shipyard							

Sovetskii Voin			20 ships	L1	rank: 4	
82.00	12.48	6.02	—	12.7	CONV	MPC
74.21	12.53	1684	—	—	—	—
5.40			1839	4	—	—
—			—	—	—	—
		2485				

cranes: 2@8 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Aleksandr Miroshnikov		1971		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Aleksandr Pankratov		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Andrey Ivanov		1970		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Arseniy Moskvina		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Konstantin Korshunov		1970		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Konstantin Savelyev		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Konstantin Shestakov		1968		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Leningradskiy Opolchenets		1970		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Leningradskiy Partizan		1970		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Nikolay Yemelyanov		1971		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Sovetskiy Moryak		1971		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		

Sovetskiy Pogranichnik Northern Shipping Company	Arkhangelsk	1970		RR Russian Federation	
Sovietskiy Voin Northern Shipping Company Vyborg Shipyard	Arkhangelsk	1968	First	RR Russian Federation	6908929
Vyacheslav Denisov Northern Shipping Company	Arkhangelsk	1971		RR Russian Federation	
Vyborgskaya Storona Northern Shipping Company	Arkhangelsk	1970		RR Russian Federation	
Yakob Kunder Northern Shipping Company	Arkhangelsk	1970		RR Russian Federation	
Yakov Reznichenko Northern Shipping Company	Arkhangelsk	1971		RR Russian Federation	
Yevgeniy Nikonov Northern Shipping Company	Arkhangelsk	1969		RR Russian Federation	

Spartak			14 ships	L1	rank: 4	
77.81	11.50	5.60	MSDG	1	12.5	CONV
69.74		1505	990	FPP		TIMB
			1100	4	4000n.mi	21
4.35	2550	1469				

1234 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Ivan Bolotnikov		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Kondratiy Bulavin		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Nikolay Bauman		1968		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Pyotr Kakhovski		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Salavat Yulayev		1969		RR		
Northern Shipping Company	Arkhangelsk			Russian Federation		
Spartak		1968	First	RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		

Stakhanovets Kotov			2 ships		L1		rank: 4	
139.50	20.20	12.60	MSDG	2	14.2	CONV	HLV	
121.00	20.25	4026	4240	CPP	20000n.mi		RORO	
—			4810	4	—	25		
—			—	—	—	—		
6.28	11149	5710						

4200 t., cont: 286@20', cranes:
2@350 t., stern door/ramp

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Stakhanovets Kotov			1978	First	RR		7616767
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Hollming Oy-Rauma							
Stakhanovets Yermolenko			1978		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		

Stroptivyi			5 ships		UL		rank: 3	
69.75	17.62	9.02	—	2	15.0	—	SALV	
60.84	18.01	2635	—	CPP	—	—	TUG	
—	—	—	5590	—	—	—	—	
6.46	—	1300	—	—	—	—	Thrusters	
—	—	—	—	—	—	—	—	

Bow thrusters.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Sibirsky			1980		RR		7808308
DalRyba		Vladivostok			Russian Federation		
Wartsilla Shipyards							
Spravedlivyy			1980		RR		7808279
DalRyba		Vladivostok			Russian Federation		
Wartsilla Shipyards							
Stakhanovets			1980		RR		7808281
SevRyba		Murmansk			Russian Federation		
Wartsilla Shipyards							
Stroptivyi	Jupiteris		1979	First			
Klaipeda Transflot		Klaipeda			Lithuania		
Wartsilla Shipyards							
Suvorovets			1980		RR		
DalRyba		Vladivostok			Russian Federation		
Wartsilla Shipyards							

SukhonaLes			L1				rank: 4
100.84	14.33	7.14	MSDG	—	—	—	MPC
93.91	14.43	3036	—	—	—	—	
5.78		3340	1471	—	—	—	
—			—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
SukhonaLes		1964		RR		6521202
Far-Eastern Shipping Co. / Vladivostok	Vladivostok			Russian Federation		

Svetlomor-1			L1			rank: 4	
61.02	14.00	6.00	—	2	12.6	CONV	TUG
51.80		1695	—	CPP	—	—	
4.50			—	4	—	—	
—			—	—	—	—	
		1000					

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
<hr/>						
Svetlomor-1		1987	First	RR		8606460
Baltic Shipping Co.	St. Petersburg			Russian Federation		
Far East - Livingston S. B. Ltd.						
<hr/>						
Svetlomor-3		1987		RR		
Murmansk Basin Authority				Russian Federation		

Taimyr			2 ships		LL2		rank: 1	
150.00	28.00	15.20	NPTE	3 1:1:1	20.2	CONS	IB	
140.60	29.20	20791	32500	FPP	Unlimited	23		
8.10	19600		36800	4		110		
		3581	1.98m @ ~2kn					

Tsoy (1989); Tsoy (1993);
Tsoy (1992); Tsoy (1990).

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Taimyr		1989	First	RR		8417481
Murmansk Shipping Co.	Murmansk			Russian Federation		
Wartsilla Shipyards						
Vaygach		1989		RR		
Murmansk Shipping Co.	Murmansk			Russian Federation		

Tebo Olimpia			1 ships	IA	rank: 4	
140.80	21.20	10.70	—	1	15.0	TANK
132.80	21.23	8825	—	CPP	—	—
7.30		11474	5560	4	—	—
—			—	—	—	Thrusters

pumps: 9@18000 t/hr.

Bow thrusters

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Tebo Olimpia			First	FR		7813327
Suomen Petrooli Oy	Helsinki			Finland		
Valmet Oy Helsingin Telakka						

Temriuk			L1			rank: 4
83.55	11.97	5.34	MSDG	—	13.5	TANK
74.00	12.04	1611	—	—	—	
4.65		1660	1471	—	—	
—			—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Beloyarsk			1970		RR		7044378
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		
Icha			1971		RR		7119458
Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii			Russian Federation		

Terry Fox			2 ships	4	rank: 1	
88.00	17.50	10.00	SSDG	2	14.0	CONS
75.00	17.94	4233	—	CPP	—	IB
8.29	6910		17060	4 4.8	1650 t.	23
—		1708	—	—	—	SUPP
8.30		2113	1.2m@7kn	—	—	TUG

800t.

Helicopter landing pad.

Low-friction, abrasion-resistant
coating "Inerta-60"

Dick.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Kalvik					CR		
Burrard Yarrows Co					Canada		
Terry Fox							
Department of the Coast Guard (Canada)	Vancouver		1983	First	CR		803579
Burrard Yarrows Co					Canada		

Thuleland			1 ships	IA SUPE			rank: 3
185.90	26.50	15.05	MSDG	1	—	—	BULK
177.00		22157	—	FPP	—	—	
11.00		31900	11200	4	—	—	
—		31400	—	—	—	—	

cont: 832@20', cranes: 5@25 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Thuleland	Singapore	1977	First	DNV Sweden		7519270
Eriksberg M.V. A.B.						

Trans Dania**IA****rank: 4**

113.60	17.50	11.00
106.40	17.75	5167
6.71		5353
—		

MSDG	1	15.0	CONC	MPC
—	CPP	—	24	RORO
3000	4 4.7	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					

Trans Dania

A/S Dania Transport K/S
German Surken

Bergen

1990

DNV
Norway

Uglegorsk			L1			rank: 4	
97.80	17.30	7.00	SSDG	1	13.1	MPC	
90.22		3936		CPP			
5.62		4168	3360				

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Chekhov			1993		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
De Kastri			1992		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Gastello			1993		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Nevelsk			1991		RR		
Sakhalin Shipping Co.		Valenta			Russian Federation		
Nikolay Kantemir	Baykovo		1992		RR		8901004
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Nogliki			1992		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Novokubansk	Shelikhova		1992		RR		8900995
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Orient Makarov	Makarov		1991		RR		8817825
Makarov Shipping Co.		Vallenta			Malta		
Uglegorsk			1990	First	RR		8817813
Mietfinanz G.m.b.h.		Nassau			Bahamas		

Uikku**1 ships****IA Super****rank: 3**

164.47	21.50	12.02
151.54	22.26	11290
9.50		16500
—		

DIEL	1				TANK
11400	APD	—	—		
12000	4	—	—		
—	—	—	—		

pumps: 8@2560 t/hr.

Formerly from "Lunni" series.
Converted in 1993 to accommodate
the 11.4 MW azimuthing
propulsion drive "Azipod". Original
medium-speed diesel, gearing,
shafting, and CP propeller
werereplaced.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Uikku		1976	First	DNV	FR	7500401
Neste Oy	Naantal/Nadendal			Finland		
Verft Nobizkrug GmbH.						

Valentin Shashin

149.40	24.00	12.60
136.80		11285
7.30	16810	7000
		7245

UL**rank: 3**

DIEL	—	13.0	—	DRIS
12800	4	—	100	
—	—	—	—	

Cranes: 1@25 t., 1@40 t.

Can drill to 6500 m. depth in
water 300 m. deep. Drilling rig is
48.8 m. tall, lifting capacity 454 t.

Elisavetchenko.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Valentin Shashin		Murmansk	1982	First	RR		7907166
					Russian Federation		

Vanino			UL			rank: 3	
113.01	18.30	8.51	—	1	14.0	—	TANK
105.24	18.53	5154	—	—	—	—	
7.20	8596		3960	—	—	24	
—			—	—	—	—	
		6237					

pumps: 11

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Vanino			1985		RR	FR	8406527
Primorsk Shipping Co.		Nakhodka			Russian Federation		

Vasilii Pronchishev			14 ships		LL4		rank: 2	
67.70	17.50	8.30	DIEL	3 1:1+0.7	14.5	CONS	IB	
62.20	18.10		3450	CPP	17days	25		
6.00	3100		3960	4	—	39		
—			—	—	—	—		
			0.7m @ ~2kn					

2 fore & 1 aft prop.

Tsoy (1993).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Fyodor Litke			1970		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Ivan Kruzenshtern			1964		RR		
Leningrad Sea Transport					Russian Federation		
Ivan Moskvitin			1971		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Khariton Laptev			1962		RR		
Sakhalin Shipping Co.		Kholmsk			Russian Federation		
Pyotr Pakhtusov			1969		RR		
Arkhangelsk Hydrography					Russian Federation		
Semyon Dezhnev			1971		RR		
Leningrad Sea Transport					Russian Federation		
Vasilii Pronchishev				First	RR		
					Russian Federation		
Yerofey Khabarov			1963		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Yuriy Lisianskiy			1965		RR		
Baltic Basin Administration					Russian Federation		

Ventspils			10 ships		UL	rank: 3	
113.00	17.06	8.50	SSDG	1	15.2		TANK
105.33	18.32	5154		FPP	4970n.mi		
			4350	4		28	
7.20	9400	6297					

4900 t., pumps: 11@1730 t/hr.

4 other sister ships in this series, unlisted in this database, are owned by Latvian Shipping Company.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Dallnerechensk		1986		RR		
Primorsk Shipping Co.	Nakhodka			Russian Federation		
Daugava		1985		RR		
Primorsk Shipping Co.	Nakhodka			Russian Federation		
Nagayevo		1986		RR		
Primorsk Shipping Co.	Nakhodka			Russian Federation		
Ussurijsk		1986		RR		
Primorsk Shipping Co.	Nakhodka			Russian Federation		
Ventspils		1983	First	RR		8129591
Latvian Shipping Co.	Riga			Latvia		
Rauma-Repola Oy						

Viiralaid				5 ships	L1	rank: 4	
80.20		8.32		MSDG	1	11.8	CONV
70.80	12.89	964		1398	CPP	4000n.mi	RORO
—				1553	4	—	17
—				—	—	—	—
4.17	2726	1455					

1274 t., cont: 115@20'

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Viirelaid			1971	First	RR		7125029
Estonian Shipping Co. Ltd.		Tallinn			Estonia		
Herman Suerken Gmbh and Co.							

Vitalii Diakonov**11 ships****L1****rank: 4**

124.24	15.80	7.50
116.96	16.40	4643
4.50		3370
5.50	8140	5031

MSDG	2	11.5	CONV	MPC
1980	FPP	6000n.mi	60	
2200	4 2.5	—	24	
—	—	—	—	

4599 t., 6680 m³, cont: 165@20',
cranes: 4@8 t.

Nikonov.

SISTER SHIPS

SHIP NAME SHIP OWNER SHIPYARD (SPECIAL FEATURES)	FORMER NAMES	HOME PORT (MODERNIZATION) (CHARTER RATE AND OP. COSTS)	YR BUILT	First?	ICE RE FLAG (NOTES)	REG	LLOYD REG#
Akademik Pozdyunin Sakhalin Shipping Co.		Kholmsk	1984		RR Russian Federation		
Nikolay Dolinskiy Far-Eastern Shipping Co. / Vladivostok		Vladivostok	1988		RR Russian Federation		
Pavel Shepelyov Kamchatka Shipping Co.		Petropavlovsk-Kamchatskii	1985		RR Russian Federation		
Professor Bubnov Sakhalin Shipping Co.		Kholmsk	1984		RR Russian Federation		
Professor Papkovich Sakhalin Shipping Co.		Kholmsk	1985		RR Russian Federation		
Professor Victor Vologdin Sakhalin Shipping Co.		Kholmsk	1986		RR Russian Federation		
Professor Vladimir Popov Sakhalin Shipping Co.		Kholmsk	1987		RR Russian Federation		
Professor Voskresenskiy YakutMorTransObyedineniye			1988		RR Russian Federation		
Valeriy Kuzmin YakutMorTransObyedineniye			1986		RR Russian Federation		
Vitaliy Diakonov Sakhalin Shipping Co. Navashinskiy Shipyard		Kholmsk	1983	First	RR Russian Federation		8227434

Vitus Bering			5 ships		ULA		rank: 2	
159.80	22.10	12.00	DIEL	1	16.4	CONS	IB	
142.40	22.40	13514	9300	FPP	15000n.mi	29	RORO	
—	—	—	11460	4	—	39	SUPP	
7.50	16200	6500	—	Nozzles	—	—	—	
8.50	18900	9200	—	—	—	—	—	
9.00	20350	10650	0.9m @ ~2kn					

8670 t. (7770 t.), cont: 326@20',
cranes: 2@25 t. 1@12.5 t. All cargo
holds can be unloaded by helicopters
Ka32 with 5 t. cargo capacity. 2 ACV
@40 t., 2 refr. holds @110 m^3,
holds 4 & 5 for heavy wheeled
machinery.

2 helicopters available, hangar
14x10x5.8 m.

Low-friction abrasion-resistant
coating "Inerta-60".

Glebko; Kosovsky; Tsoy
(1993); Tsoy (1992).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Aleksey Chirikov			1987		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kherson Shipyard							
Stepan Krashennikov			1989		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kherson Shipyard							
Vasilliy Golovnin			1988		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kherson Shipyard							
Vitus Bering			1987	First	RR		8624383
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kherson Shipyard							
Vladimir Arsenjev			1987		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Kherson Shipyard							

Vohilaid**UL****rank: 3**

49.70	4.80	DIEL	2	12.5		FERR
—	12.80	820	1420	—	—	RORO
—		—	—	—	—	
3.00		—	—	—	—	Thrusters
—		—	—	—	—	

Bow thrusters @135 kW.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Vohilaid		1983	First	RR		8227173
Estonian Shipping Co. Ltd.	Tallinn			Estonia		
Riga Shipyards						

VolgoLes			4 ships		L1		rank: 4	
123.90	16.70	8.45	SSDG	1	14.8	CONV	TIMB	
115.00		4638	2980	FPP	7000n.mi			
			3310	4		25		
6.82	9220	5895						

5166 t.

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
AlatyrLes			1962		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
DvinoLes			1960		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
KomiLes			1960		RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		
VolgoLes			1960	First	RR		
Baltic Shipping Co.		St. Petersburg			Russian Federation		

Westerstern			2 ships		E3		rank: 4	
110.00	17.70	10.60	SSDG	1	12.5	CONV	CHEM	
104.60		5480	3600	CPP	5000 mi.	45	TANK	
8.54		9025	—	— 3.1	—	19		
—			—	—	—	—		

10000 m³.

Double-hull design.

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
Oderstern		1992		GL		9035838
Chemical Carriers Ltd.	Douglas			Great Britain		
MTW Schiffbau Werft						
Westerstern		1992	First	GL		9035826
Chemical Carriers Ltd.	Douglas			Great Britain		
MTW Schiffbau Werft						

World Discoverer**IA****rank: 4**

15.20	6.25	—	1	16.5	—	PASS
72.70	3153	—	CPP	—	—	
4.46	3080	720	3529	4	—	
—			—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER	HOME PORT			FLAG		
SHIPYARD	(MODERNIZATION)			(NOTES)		
(SPECIAL FEATURES)	(CHARTER RATE AND OP. COSTS)					
World Discoverer		1974	First	ABS		7401269
Adventurer Cruises Inc.	Monrovia			Liberia		
Schiffbau Ges.Unterweser A.G.						

Yasnyi		
81.16	15.97	7.22
71.46	16.30	2737
4.90		
—		1329

UL

rank: 3

—	2	15.3	CONV	SUPP
—	CPP	—	—	TUG
—	4	—	—	
—	—	—	—	

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
<hr/>							
Irbis			1986		RR		
Far Eastern Basin Administration					Russian Federation		
<hr/>							
Radon			1987		RR		
Sakhalin Basin Administration					Russian Federation		
<hr/>							
Umka			1987		RR		
Murmansk Basin Authority					Russian Federation		
<hr/>							
Yasnyi			1985	First	RR		8422242
Baltic Shipping Co.		St. Petersburg			Russian Federation		
Stocznia Gdanska im. Lenina							

Yermak			3 ships		LL2		rank: 1	
135.00	25.60	16.70	DIEL	3 1:1:1	19.5	CONS	IB	
130.00	26.00	12231	26500	FPP	28days	26		
11.00	20240		30420	4 5.4	—	91		
—			—	—	—	—		
		7560	1.8m @ ~2kn					

cranes: 2@10 t.

Tsoy (1993); Tsoy (1992);
Tsoy (1990).

SISTER SHIPS

SHIP NAME	FORMER NAMES	HOME PORT	YR BUILT	First?	ICE RE	REG	LLOYD REG#
SHIP OWNER		(MODERNIZATION)			FLAG		
SHIPYARD		(CHARTER RATE AND OP. COSTS)			(NOTES)		
(SPECIAL FEATURES)							
Admiral Makarov			1975		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Krasin			1976		RR		
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Yermak			1974	First	RR		7330038
Far-Eastern Shipping Co. / Vladivostok		Vladivostok			Russian Federation		
Oy Wartsila Ab							

SHIP OWNERS BY COMPANY NAME

Alphabetical listing of ship owner companies and the ships owned by them.

OWNER ENTRY LAYOUT

Company name

Telephone and fax

Street or mailing address

Telex

City, state/province, postal code, country

Listing of ships owned (this listing does not attempt to list all ships owned by the company)

OWNERS LISTING

A/S Dania Transport K/S
Wernersholmve 5, Postboks C.
Hop, 5043, Norway
Trans Dania

Tel: +5 91 22-30
Telex: 42433 seatr

Fax: +5 91 22-41

Academy of Sciences of Russian Federation
Akademik Ioffe Akademik Sergei Vavilov

Adventurer Cruises Inc.
W-2800
Bremen 34, Germany
World Discoverer

Tel: +0421 238-030

Fax: +0421 238-0333

AIF Shipping Company
Sasha Borodulin

AKFES Shipping
Svirsk

Amoco Canada Research Ltd.
Canmar Kigiriak

Antarctic Shipping Pty. Ltd.
Suite 20, Galleria Salamanca, Salamanca Place
Hobart, Tasmania, Australia
Aurora Austrelis

Tel: +02 240-666
Telex: 58247

Fax: +02 240-053

Aqua Ltd. Shipping
Yuvent

Arctic and Antarctic Research Institute
, Russia
Mikhail Somov

Arkhangelsk Hydrography
Ivan Kireyev
Sergey Kravkov

Nikolay Kolomeytsev
Valerian Albanov

Pavel Bashmakov
Yakov Smirnit'skiy

Pyotr Pakhtusov

Aspol Shipping Co. Ltd.
3A Pushkinskaya St.
Murmansk, Russian Federation
Bukhtarma

Telex: 126158 ASPOL SU

Azov Shipping Co.
Kapitan Belousov

Krymsk

Baikal Shipping Co.
Baykal

Baltic Basin Administration
Yuriy Lisyanskiy

Baltic Shipping Co.
5 Mezhevoi Kanal
St. Petersburg, Russian Federation

Tel: +7/812/216-9326 Fax: +7/812/186-8544
Telex: 121501 BSC SU

AlatyrLes	Aleksandr Prokofyev
Estonia	Geraki
Indiga	IrtysLes
Jose Diaz	Kaliningrad
Kapitan Chmutov	Kapitan Gastello
Kapitan Kanevskiy	Kapitan Kozlovskiy
Kharlov	Kimry
Kosmonavt Pavel Beliayev	Kosmonavt V. Patsayev
Krasnoborsk	Kuzminki
Lomonosovo	Mikhail Kalinin
Novaya Ladoga	Pavlovsk
Saldus	Sergei Kirov
Stakhanovets Kotov	Stakhanovets Yermolenko
Turku	Vasya Alekseyev
Yantarnyi	Yasnyi

DvinoLes
Guse-Khrustalnyi
IzhmaLes
KamaLes
Kapitan Gavrilov
Kapitan M. Izmailov
Kingisepp
Kosmonavt V. Volkov
Ladogales
NevaLes
Pioner Vyborga
Sestroretsk
Svetlomor-1
Velikiy Ustyug

EPRON
Ilyich
IzhoraLes
Kapitan Beklemishev
Kapitan Goncharov
Kapitan Primak
KomiLes
KostromaLes
Ligovo
Nikolay Tikhonov
Professor Tovstykh
Sofja Perovskaya
Tikhon Kiselyov
VolgoLes

Bundesminister fur Forschung und Tech. (Germany)
, Germany
Polarstern

Canadian Marine Drilling
, BC, Canada
Canmar Explorer

Canmar Explorer II

Ikaluk

Miscaroo

Chemical Carriers Ltd.

Oderstern

Weserstern

DalRyba

Ul. Leninskaya 51

Vladivostok, Russian Federation

Sibirsky

Spravedlivyy

Suvorovets

Deep Ocean Drilling Inc.

, Panama

Discoverer Seven Seas

Department of the Coast Guard (Canada)

8th floor, Canada Bldg., Minto Pl., 344 Slater St.

Ottawa, ON, K1A 0N7, Canada

Franklin

Grosselier

Pierre Radisson

Terry Fox

Tel: 63-995-47-

Telex: 05303128

DVVIMU

Ilijinsk

Estonian Shipping Co. Ltd.

Estonia pst. 3/5

Tallinn, Estonia

Viirelaid

Vohilaid

Tel: +372 2 631-2182

Telex: 173272

Fax: +372 2 424-958

Far Eastern Basin Administration

Bars

Irbis

Far-Eastern Shipping Co. / Vladivostok**Ul. 25-go Oktyabrya 15****Vladivostok, Russian Federation**

Admiral Makarov	Aleksandr Fadeyev
Aleksey Kosygin	Amderma
Antonina Nezhdanova	Arkadiy Kamanin
Botsman Moshkov	Bratsk
Gorno-Altaysk	Igarka
Ivan Moskvitin	Ivan Syrykh
Kapitan Dublitskiy	Kapitan Gnezdilov
Kapitan Kondratjev	Kapitan Krems
Kapitan Milovzorov	Kapitan Myshevskiy
Kapitan Shevchenko	Kapitan Tsurul'
Kavalerovo	Kem'
Konstantin Petrovskiy	Koporje
Kulunda	Lakhta
Leningrad	Lyonya Golikov
Mariya Savina	Mekhanik Gordienko
Mikhail Svetlov	Moskva
Nizhneyarsk	Olga Sadovskaya
Pioner Nakhodki	Pioner Primorya
Pionerskaya Zor'ka	Posyet
Shadrinsk	Slavyanka
Tolya Shumov	Topaz
Vasiliy Fedoseyev	Vasiliy Burkanov
Vitya Chalenko	Vitya Khomenko
Vladimir Mordvinov	Vladivostok
Yermak	Yerofey Khabarov

Tel: +7/423/224-32**Telex: 213115 MRF SU**

Aleksandr Tvardovskiy	Aleksey Chirikov
Anadyr	Anatoliy Kolesnichenko
Baykonur	Borya Tsarikov
Dzhurma	Elektrostal'
Igor Ilyinski	Ivan Makarjin
Kansk	Kapitan Bakanov
Kapitan Gotskii	Kapitan Khlebnikov
Kapitan Lyubchenko	Kapitan Mann
Kapitan Samoylenko	Kapitan Sergiyevskiy
Kapitan Vasilevskiy	Karaga
Kiev	Kolya Myagotin
Kovdor	Krasin
Lara Mikheyenko	Lazurit
Lyubov Orlova	Magadan
Mekhanik Rybachuk	Mikhail Prishvin
Murmansk	Nikolay Dolinskiy
Pioner Chukotki	Pioner Kirghizii
Pioner Slavyanki	Pioner Vladivostoka
Sasha Kondratyev	Sasha Kotov
Stepan Krashennikov	SukhonaLes
Ussuri	Valeriy Volkov
Vasiliy Golovnin	Vitus Bering
Vitya Sitnitsa	Vladimir Arsenjev
Vysokogorsk	Yelena Shatrova
Zina Portnova	

Finnish Board of Navigation**Vuorimiehenkatu 1, Postboks 158****00141 Helsinki, Helsingfors 14, Finland**

Aranda

Otso

Urho

Tel: +90 18081**Telex: 121471****Fax: +90 1808431****Frontier Croises Ltd.****Nassau, Bahamas**

Frontier Spirit

Gulf Offshore N.S. Ltd.**41 Regent Quay****Aberdeen, AB1 2BE, UK**

Highland Sentinel

Tel: +0224 210-344**Telex: 97471****Fax: +0224 210-343****Igarka Hydrography**

Nikolay Yevghenov

Kamchatka Shipping Co.**Ul. Radiosviazi 65****Petropavlovsk-Kamchatskii, Russian Federation**

Almaz	Beloyarsk
Kamchadal	Kamchatskiy Komsomolets
Krasnoyarsk	Marat Kazey
Pavel Shepelyov	Petropavlovsk
Sernovodsk	Shushenskoye
Sofiysk	Surgut

Chazhma
Kikhchik
Mirnyi
Petropavlovsk-Kamchatsk
Slautnoye
Tayga

Icha
Kozyrevsk
Palana
Pioner
Snezhnogorsk
Vaga

Tel: +7 41522 222-63**Telex: 244112 SU****Fax: +7 41522 219-60**

Karmi Ltd.
Ul. masti 7
Tallinn, Estonia
Abakan

Telex: 238590

Klaipeda Transflot
Ul. Nemuno 22
Klaipeda, Lithuania
Stroptivyi

Tel: +7/1261/395-85 **Fax: +7/1261/742-56**
Telex: 278133 MOROZ

Laivanisannistoyhtio Raiifellow
Helsinki, Finland
Finnfellow

Finnmaid

Latvian Shipping Co.
2 Boulevard Basteya
Riga, Latvia
Aleksandr Kaverznev

Tel: +371 2 325-719 **Fax: +371 2 322-888**
Telex: 161121 MRFRG SU

Ventspils

Leningrad Sea Transport
Ivan Kruzenshtern

Semyon Dezhnev

Libby G.
Hovfaret 4
0275 Oslo, 2, Norway
Libby G

Tel: +02 50-22-80 **Fax: +02 50-08-54**

Makarov Shipping Co.
, Malta
Orient Makarov

Mietfinanz G.m.b.h.
Nassau, Bahamas
Uglegorsk

Ministry of Gas Industry of the Russian Federation
Anna Akhmatova

Murmansk Basin Authority
Svetlomor-3

Umka

Murmansk Hydrometeorology
Otto Schmidt

Murmansk Shipping Co.
15 Kominterna St.
Murmansk, Russian Federation

Tel: +7 815 00 104-91 Fax: +7 815 00 104-95
Telex: 126113 MRF SU

Admiral Ushakov	Aleksandr Nevskiy
Anatoliy Lyapidevskiy	Arkhangelsk
Dmitriy Pozharskiy	Dmitry Donskoi
Ivan Papanin	Ivan Susanin
Kapitan Chukhchin	Kapitan Danilkin
Kapitan Nazarjev	Kapitan Nikolayev
Kapitan Vakula	Kapitan Vodenko
Konstantinovka	Kuzma Minim
Mikhail Kutuzov	Mikhail Strekalovski
Navarin	Nikel
Norilsk	Olenegorsk
Pavlik Larishkin	Pyotr Velikiy
Shura Kober	Sibir
Stepan Razin	Taymyr
Tolya Bodarchuk	Valya Kotik
Victor Tkachev	Volodya Sherbatsevich
Yuriy Arshenevskiy	Yuriy Dolgorukiy

Aleksandr Suvorov
 Arktika
 Fastov
 Kandalaksha
 Kapitan Dranitsyn
 Kapitan Sorokin
 Klavdia Yelanskaya
 Lenin
 Monchegorsk
 Nikolayevsk
 Pavel Ponomaryov
 Rossia
 Sovetskiy Soyuz
 Tiksi
 Vasya Korobko
 Yamal
 Yuta Bondarovskaya

Alla Tarasova
 Balkhash
 Ivan Bogun
 Kapitan Bochek
 Kapitan Kudlay
 Kapitan Sviridov
 Kola
 Mariya Yermolova
 Murman
 Nina Kukoverova
 Pavel Vavilov
 SevMorPut
 Spartak
 Tim Bak
 Vaygach
 Yemeljan Pugachyov

Neste Oy
PO Box 29
02151 Espoo/Esbo, Finland
 Kiisla

Telex: 126162

Fax: 450-4777

Lunni

Uikku

Northern Shipping Company
Nab. Lenina, 36
Arkhangelsk, Russian Federation

Aleksandr Miroshnikov	Aleksandr Pankratov
Arseniy Moskvinn	Bakaritsa
Belomorye	Cherepovets
Iogann Makhmatal'	Isakogorka
Ivan Shadr	Kapitan Burmakin
Kapitan Lus	Kapitan Mochalov
Kapitan Zamyatin	Kapitan Zhehtovskiy
Konstantin Savelyev	Konstantin Shestakov
Kuloy	Leningradskiy Opolchenets
Mekhanik Brilin	Mekhanik Fomin
Mekhanik Pustoshnyi	Mekhanik Pyatlin
Nikolay Bauman	Nikolay Novikov
Palanga	Pandora II
Pavlin Vinogradov	Pechenga
Petrokrepost	Petrovskiy
Pioner Belorussii	Pioner Estonii
Pioner Litvy	Pioner Moldavii
Pioner Severodvinska	Pioner Yakutii
Ponoy	Pulkovo
Pyotr Kakhovskiy	Pyotr Smidovich
SelengaLes	Sosnovets
Sovietskaya Yakutiya	Sovietskiy Voin
Vera Mukhina	Vladimir Timofeyev
Vyacheslav Denisov	Vyborgskaya Storona
Yekaterina Belashova	Yevgeniy Nikonov

Anatoliy Sibiryakov
 Bakhchisaray
 Fyodor Varaskin
 Istra
 Kapitan Glazachev
 Kapitan Ponomaryov
 Kondraty Bulavin
 Konstantin Yuon
 Leningradskiy Partizan
 Mekhanik Kotsov
 Mekhanik Yartsev
 Nikolay Yemelyanov
 Pargolovo
 Perm'
 Petrozavodsk
 Pioner Karelii
 Pioner Moskvii
 Plesetsk
 Pushlakhta
 Pyotr Strelkov
 Sovetskiy Moryak
 Teodor Nette
 Vlas Nichkov
 Yakob Kunder
 Zolotitsa

Andrey Ivanov
 BelomorskLes
 Igor Grabar
 Ivan Bolotnikov
 Kapitan Glotov
 Kapitan Sakharov
 Konstantin Korshunov
 Kotlas
 Maymaksa
 Mekhanik Makarjin
 Mikhail Cheremnykh
 Oka
 Pavel Korchagin
 Pertominsk
 Pioneer Arkhangelska
 Pioneer Kazakhstana
 Pioneer Oneghi
 Pomorje
 Pustozersk
 Salavat Yulayev
 Sovetskiy Pogranichnik
 Vasiliiy Musinskiy
 Vostok-2
 Yakov Reznichenko

Polar Chart Company
 Tolya Komar

Primorsk Shipping Co.**Ul. Pogradichnaya 6****Nakhodka, Primorski Krai, 692900, Russian Federation****Tel: +7 42366 44361****Fax: +7 42366 56078****Telex: 213812 PSC Su**

Angarsk	Arsenyev	BAM	Belogorsk
Beryozovo	Dallnerechensk	Daugava	Gornopravdinsk
Guryev	Igrim	Kamensk-Uralskiy	Kapitan Djachuk
Kapitan Dotsenko	Kapitan Kobets	Kapitan Nevezhkin	Kapitan Shevtsov
Nadym	Nagayevo	Nikopol	Nizhnevartovsk
Partizansk	Roschino	Samotlor	Shkotovo
Svobodnyi	Urengoy	Usinsk	Ussurijsk
Vanino	Viluysk	Yeniseysk	

Providenie Hydrography

Fyodor Matisen

Stepan Malyghin

Rigel Schiffahrts

Elbestern

Emsstern

Rheinstern

Rigorous Shipping Co. Ltd.**, Cyprus**

Anna Karenina

Sakhalin Basin Administration

Radon

Sakhalin Shipping Co.**Ul. Pobedy 16****Kholmsk, Sakhalin, Russian Federation****Tel: +7/228-03****Fax: +7/255-84****Telex: 412613 SSC SU**

Akademik Pozdyunin	AltayLes	Anton Buyukly	Atlas
Ayan	Blagoveshensk	Boris Nikolaychuk	Chekhov
Darasun	De Kastri	Egvekinot	Fyodor Litke
Gastello	Kapitan Kiri	Katangli	Kemerovo
Khariton Laptev	Khatanga	Kholmsk	Kolguyev
Komsomolets Sakhalina	Krasnopolye	Krasnoturjinsk	Kuznetsk
Nevelsk	Nikolay Kantemir	Nogliki	Novokubansk
Okha	Omolon	Orehovo-Zuyevo	Paramushir
Paromay	Pavlovo	Pervouralsk	Pioner Buryatii
Pioner Kamchatki	Pioner Kholmska	Pioner Rossii	Pioner Uzbekistana
Pioner Yu. Sakhalinska	Pobedino	Poronaysk	Poronin
Primorje	Professor Bubnov	Professor Papkovich	Professor Victor Vologdin
Professor Vladimir Popov	Przhevalsk	Raychikhinsk	Rubin
Sakhalin-1	Sakhalin-10	Sakhalin-2	Sakhalin-3
Sakhalin-4	Sakhalin-5	Sakhalin-6	Sakhalin-7
Sakhalin-8	Sakhalin-9	SakhalinLes	Shatura
SibirLes	Sibirtsevo	Stepan Savushkin	Tampere
Terney	Tobol	Tymovsk	Ulan-Ude
Vitaliy Diakonov	Voskresensk	VyatkaLes	Vzmorje
Yana	Yevgeniy Chaplanov	Yuriy Savinov	Zabaykalsk

Sakhalin-Lyaonin
Korsakov

SevRyba
Ul. Kominterna 1
Murmansk, Russian Federation
Stakhanovets

Telex: 126112 SU

SICO Ltd.
The Grenadines
Drogobych

SoyuzMorGeo
Azerbaidjan
Akademik Nalivkin

Suomen Petrooli Oy
Lounrotikatu 18, PO Box 199
Helsinki 10, Helsingfors, 00101, Finland
Tebo Olimpia

Tel: 17291
Telex: 122519

Fax: 172-9314

Svensk Isbrytarkonsortium KB
Oden

The National Maritime Administration of Sweden
Atle

The Royal Trust Co.
Arctic

Tiksi Hydrography
Dmitriy Sterlegov

Eduard Toll

Vladimir Sukhotskiy

Transport Canada (Gov't of Canada)
28th floor, Area E Tower C, Place de Volle
Ottawa, ON, K1A 0N5, Canada
Henry Larsen

Tel: 613-996-7501
Telex: 053-3128

Fax: 613-995-7501

Louis S. St. Laurent

Ture TA Axelsson
Baltic Press

Baltic Print

UK Navy Dept.
, United Kingdom
Polar Circle

Ukraine D.S.
Novy Donbass

US Coast Guard
2100 2nd St. SW
Washington, DC, 20593, USA
Katmai Bay

Tel: 202-426-2158
Telex: 892427

Polar Sea

Polar Star

VietSovLikhter
Kirensk

YakutMorTransObyedineniye
Afanasiy Bogatryyov
Ivan Strod
Valeriy Kuzmin

Fyodor Okhlopkov
Maksim Ammosov

Fyodor Popov
Platon Oiunskiy

Isidor Barakhov
Professor Voskresenskiy

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestion for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE June 1995		3. REPORT TYPE AND DATES COVERED	
4. TITLE AND SUBTITLE Northern Sea Route Reconnaissance Study: A Summary of Icebreaking Technology				5. FUNDING NUMBERS	
6. AUTHORS Devinder S. Sodhi					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Cold Regions Research and Engineering Laboratory 72 Lyme Road Hanover, New Hampshire 03755-1290				8. PERFORMING ORGANIZATION REPORT NUMBER Special Report 95-17	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Engineer District, Alaska Anchorage, Alaska				10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. Available from NTIS, Springfield, Virginia 22161				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Since the advent of steam power, icebreakers have been built to navigate in ice-covered waters. The hull forms of early icebreakers were merely an adaptation of open water hull shapes, by sloping bow angles more to create vertical forces for breaking ice in bending. However, these bow forms were found to be unsuitable for sea-going vessels because they push broken ice ahead of them. This experience led to construction of all sea-going vessels with wedge-shaped bows from 1901 to 1979. With the introduction of low-friction coatings and the water-deluge system, it is now possible to operate ships with blunt bows efficiently in broken ice. New developments in marine propulsion technology have also been incorporated to obtain better icebreaking efficiency and performance. Both fixed-pitch and controllable-pitch propellers are in use. Nozzles surrounding the propellers are also used to increase the thrust and to reduce ice-propeller interaction. Electrical and mechanical transmission systems have been used in icebreakers to improve the characteristics of the propulsion system. Though many types of prime movers are used in icebreakers, medium-speed diesel engines are the most popular because of their overall economy and reliability. Appendix A is a description of the Russian icebreaker <i>Yamal</i> , which is one of the largest and most powerful icebreakers of the world today. Appendix B contains an inventory of existing ships that are capable of navigating in at least 0.3-m-thick ice. Some of the present icebreakers are capable of					
14. SUBJECT TERMS Auxiliary systems Hull forms Icebreakers Icebreaking history Inventory of icebreaking ships Propulsion system				15. NUMBER OF PAGES 239	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL		

13. ABSTRACT (cont'd).

navigating almost anywhere in the ice-covered waters of the Arctic and the Antarctic, and multi-purpose icebreakers have been built to operate not only in ice during the winter but also in open water doing other tasks during the summer. With sufficient displacement, power, navigation equipment, and auxiliary systems, future icebreakers that can operate independently year-round in the Arctic and the Antarctic are well within the known technology and operational experience.